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VOL. CXLI.—No. 3668] LONDON: FRIDAY EVENING, APRIL 16, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. STEEL BOILER TUBES.
2. COPPER FIRE-BOX PLATES.
3. RAILS and FISH-PLATES.
4. STEEL TYRES for LOCOMOTIVES.
5. WHEELS and AXLES.
6. UNDERFRAMES with BODY IRONWORK and FITTINGS for RAILWAY CARRIAGES.
7. HYDRAULIC BUFFER STOPS.

Tenders due on the 27th April, 1926, for Nos. 1 to 3, on the 30th April, 1926, for No. 4, and on the 11th May, 1926, for Nos. 5 to 7.
Tender forms obtainable from the above. 2183

G.I.P. RLY. ELECTRIFICATION.

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
STEEL-FRAME BUILDINGS for LOCOMOTIVE REPAIR SHOP at KALYAN.
Tenders due on the 14th May, 1926, 2 p.m.
Specification and form of Tender obtainable from the above at a fee of 5s., which will not be returned. 2184

Assistant Architect Required by the GOVERNMENT of KENYA COLONY for a tour of 30 months' service. Salary £650 a year. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, must be Corporate Members of the Royal Institution of British Architects by examination and have had experience in the design and execution of municipal and domestic buildings.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14434. 2153

Architectural Draughtsman REQUIRED by the GOVERNMENT of KENYA COLONY for a tour of 30 months' service. Salary £500 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, 25 to 35 years of age, should have taken an honours course at some approved Technical College with success. Should have a thorough knowledge of building construction and preferably have had experience in the design of municipal and domestic architecture. Should be accomplished draughtsman with knowledge of perspective drawing.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14435. 2184

Civil Engineer Required by the GOVERNMENT of NYASALAND for the PUBLIC WORKS DEPARTMENT. The selected candidate will be eligible for admission to the permanent and pensionable establishment after the completion of two tours of 20 to 30 months' continuous residential service or five years' satisfactory service on agreement. Salary £400, rising to £500 a year by annual increments of £20 and thence to £600 a year by annual increments of £25. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 30, must be A.M.I.C.E. or hold equivalent professional qualifications and have had good experience on road survey and construction. Experience in the design and erection of steel and timber bridges and buildings is also necessary. Must be able to ride a motor bicycle.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/14385. 2132

Civil Engineer Required by the GOVERNMENT of the GOLD COAST for the Lay-out of the Takoradi Township, for a tour of not less than 12 nor more than 18 months' residential service in the first instance. Salary £480 a year for the first three years of service, then £510, rising by annual increments of £30 to £720 a year, and thence by annual increments of £40 to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and liberal leave on full salary. Candidates, aged 25 to 40, must be A.M.I.C.E. or possess a degree in engineering recognised by the Institute as exempting from Parts A and B of the examination. Must be good surveyors and have had experience in Road Construction, Town Planning and Drainage Work. Candidates possessing other engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting at head of application M/14373. 2106

Roads Engineer Required by the GOVERNMENT of KENYA COLONY for a tour of 20 to 30 months' service, with possible extension. Salary £1000 a year. Free passages and quarters and liberal leave on full salary. Candidates, not over 45 years of age, must be thoroughly trained and experienced Civil Engineers, and have specialised in the organisation and construction of earth roads by machinery. Preference given to members of the Institution of Civil Engineers.—Apply at once by letter, stating age, qualifications and experience, to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14948. 2135

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

BUFFER CASES AND PARTS.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 14th April, 1926.

A fee of 20s. will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Monday, 26th April, 1926.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
Secretary.

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The Engineer

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PUBLIC NOTICES

Bolton Corporation Waterworks.
COMPLETION OF THE BELMONT RESERVOIR REPAIR WORKS.
FOR SALE.

3 Mather and Platt CENTRIFUGAL PUMPS, each electrically dir ct driven, mounted on carriage, capacity 2800 g.p.m. at 70ft. head, motor 88 B.H.P., 1470 r.p.m., 400 v., 3-phase, 50 p.

1 Isles ELECTRICALLY DRIVEN DOUBLE BARREL WINCH, direct and friction drive, capacity 2½ tons direct from barrel, 500ft. 2in. circum. rope in 2 laps each barrel. Motor 25 B.H.P., 400 v., 3-phase, 50 p.

1 Anderson-Grice 3-Ton ELECTRICALLY DRIVEN DERRICK CRANE, 25ft. jib, with PRIESTMAN GRAB. Motor 12 B.H.P., 400 v., 3-phase, 50 p.

1 Ingersoll-Rand E.R.I. AIR COMPRESSOR for belt drive, 223 cu. ft. f.a.p.m. at 100 lb. sq. inch, with air receiver, 8ft. high, 3ft. diam.

1 Yarwood LAUNCH TUG, 20ft. by 8ft. by 3ft. 8in., having timber hull and "Gardner" 3-cyl. 40 H.P. petrol-paraffin engine.

1 Yarwood DROP BOTTOM STEEL HOPPER PONTOON, 25ft. by 14ft. by 4ft. 9in., capacity 30 tons rubble stone, built in sections, suitable for road transport.

About 450 Lin. Yds. 21in. dia. LAP-WELDED STEEL PIPES, 8, and 8., ¼in. metal.

About 160 Lin. Yds. 12in. dia. WELDLESS STEEL PIPES, flanged, 1 G. metal.

The above plant has been little used, and is in excellent condition.

Further particulars and permission to view may be obtained from, and offers to be submitted to, Mr. JOHN K. SWALES, Waterworks Engineer, St. George's-street, Bolton. 2146

The South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

2332 TONS B.S. No. 90 "R" F.B. RAILS.
821 TONS B.S. No. 75 "R" F.B. RAILS.
13,508 TONS B.S. No. 60 "R" F.B. RAILS.
6441 TONS B.S. No. 50 "R" F.B. RAILS.
3596 TONS B.S. No. 40 "R" F.B. RAILS.
Together with FISH-PLATES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Rails and Fish-plates," must be left with the undersigned not later than Twelve Noon on Friday, the 30th April, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of £1 for each copy of the specification.

W. B. REYNOLDS,
For Managing Director.

91, Petty France, S.W. 1,
13th April, 1926. 2179

PUBLIC NOTICES

City of Birmingham.
WATER DEPARTMENT.
SALE OF PUMPING MACHINERY.

TENDERS are INVITED for the PURCHASE, DISMANTLING and REMOVAL of PUMPING MACHINERY, BOILERS, &c., at Selly Oak Pumping Station, near Birmingham, comprising :—

One 60 H.P. Cornish Pumping Engine, manufactured by Messrs. James Watt and Co., of Soho ;

Two Lancashire Boilers (old), Steam Pipes, &c.

Full particulars, together with form of Tender and permit to view, may be had on application to the undersigned.

J. H. BROADLEY,
Secretary.

Water Department,
Council House, Birmingham,
6th April, 1926. 2068

City of Nottingham.
BOARD OF GUARDIANS.

The Board of Guardians for the City of Nottingham invite TENDERS for NEW ELECTRIC GENERATING PLANT at their Basthorpe Institution as follows :—

SECTION No. 1.—One 60 K.W. D.C. Turbo-Generator and Branch Pipe Work Connections.
SECTION No. 2.—Alterations to Main Switchboard and Cable Connections.

Persons desiring to Tender must communicate their intention to Mr. W. C. C. Hawtayne, M.I.E.E., of 9, Queen Street-place, London, E.C. 4, the Consulting Engineer for the scheme, on or before the 23rd April, 1926, stating clearly the contract or contracts for which they desire to Tender.

Persons tendering are at liberty to Tender for either or both Sections, but not for part of a Section. Tenders for part of a Section or for supply and delivery only will not be considered bona fide Tenders.

Specifications will be issued on or about the 5th May to persons who have complied with the above requirement and who, after receiving notice from the Consulting Engineer, send to the undersigned a deposit of Two Pounds in Treasury notes for each specification required. The deposit will be returned on receipt of a bona fide Tender on or before the prescribed date.

Extra copies of the specification can be obtained on remitting Half-a-guinea for each copy, which amount will not be returnable.

Tenders, sealed and endorsed "Electricity Generating Plant, Section No. —," to be delivered to the undersigned on or before Twelve o'clock Noon on the 31st May, 1926.

The Guardians do not bind themselves to accept the lowest or any Tender.

J. ALLAN BATTERSBY,
Clerk to the Guardians.

Poor Law Offices,
Shakespeare-street, Nottingham,
14th April, 1926. 2165

PUBLIC NOTICES

County Borough of Dublin.
EXTENSION OF TIME FOR TENDERS FOR MECHANICAL WATER FILTERS.

NOTICE IS HEREBY GIVEN that the LATEST DATE for LODGEMENT of above TENDERS, i.e., the 26th April, 1926, as mentioned in the public advertisement dated 31st March, 1926, has now been EXTENDED to the 10th MAY, 1926.

JOHN J. MURPHY,
Town Clerk.

City Hall, Dublin,
10th April, 1926. 2138

Edinburgh Corporation Gas Department.
STEAM LOCOMOTIVE.

The Magistrates and Council invite TENDERS for the SUPPLY and DELIVERY at their Granton Works of a FOUR-WHEELED SADDLE-TANK STEAM LOCOMOTIVE, outside cylinder type.

Full particulars of requirements may be obtained from the Engineer and Manager, 15, Calton-hill, Edinburgh.

Tenders, endorsed "Steam Locomotive," to be lodged with the undersigned not later than 10 a.m. on Tuesday, 20th April, 1926.

The Magistrates and Council are not bound to accept the lowest or any Offer.

A. GRIERSON, S.S.C.,
Town Clerk.

City Chambers, Edinburgh,
9th April, 1926. 2141

Liverpool Corporation Waterworks.
VYRNWY SUPPLY.
THIRD INSTALMENT.
CONTRACT NO. 2.
PIPE LAYING.

The Water Committee of the Liverpool Corporation are prepared to receive TENDERS from competent persons willing to enter into a contract for the LAYING of STEEL PIPES of 42in. internal diameter and other ancillary WORKS, as follows :—

From Hirnant to Wern-Ddu, in the County of Montgomery, and from Lloran-Ganol to Bodilth, in the County of Denbigh, for a distance of about 4¼ miles.

The plans and sections may be inspected and copies of the specification and form of Tender obtained on and after Monday, the 5th instant, at the Water Engineer's Office, Alexandra Buildings, 55, Dale-street, Liverpool, upon payment of the sum of Five Guineas, which amount will be returned upon receipt of a bona fide Tender.

Tenders, endorsed "Tender for Pipe Laying," are to be sent through the post in a sealed envelope, addressed "Chairman of the Water Committee, Town Clerk's Office, Municipal Buildings, Liverpool," so as to be delivered not later than Twelve o'clock Noon on Monday, the 26th April, 1926.

The Water Committee do not bind themselves to accept the lowest or any other Tender.

WALTER MOON,
Town Clerk.

Municipal Buildings, Liverpool,
April, 1926. 2080

Rochester and Chatham Joint Sewerage Board.
MAIN OUTFALL SEWER AND DISPOSAL WORKS.
CONTRACT NO. 4.

The Board is prepared to receive TENDERS for the COMPLETION of the CONSTRUCTION of the MAIN OUTFALL SEWER, consisting of Laying about 3194 Yards of 26in., 28in., and 32in. Cast Iron Pipes in double pipe line; and the Construction of about 241 Yards of Concrete Sewer Culvert, size 5ft. 3in. high by 3ft. 6in. wide, together with appurtenant works. Also for the CONSTRUCTION of NEW SEWAGE DISPOSAL WORKS, comprising Grit Tanks, Screens, Sewage Carriers, Storm Tanks, Settling Tanks, Sludge Drying Beds, Power-house, Pump-house, Offices, and all appurtenant Works at Motney Hill, near Rainham, Kent.

Also for LAYING about 924 Yards Lineal of 24in., 26in., and 42in. CAST IRON PIPES on the site, and 494 Yards Lineal of 36in. and 42in. CAST IRON TIDAL OUTFALL PIPES on WOOD PILING.

The works are part of the Board's scheme of sewerage which is approved for grant by the Unemployment Grants Committee, and that Committee has laid down as a condition that all contracts for or incidental to the works are to be placed in this country.

The Board will require that all goods and materials supplied shall be of British production and manufacture.

Plans may be seen and quantities and form of Tender obtained on and after the 19th April at the office of the Engineers, Messrs. W. H. Radford and Son, Chartered Civil Engineers, Albion Chambers King-street, Nottingham, and also at my office, as under, on deposit of Ten Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities, &c.

Sealed Tenders, endorsed "Contract No. 4—Disposal Works," to be delivered to me at my office, as under, on or before the 29th May, 1926.

The Board does not bind itself to accept the lowest or any Tender.

By Order,
E. W. WATKINS,
Clerk to the Board.

13, New-road, Chatham Kent,
April 12th, 1926. 2144

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PUBLIC NOTICES

TENDER.

Metropolitan Borough of Bermondsey.

NEW BATHS, GRANGE-ROAD.
ENGINEERING WORK FOR SECOND CONTRACT.

The Bermondsey Borough Council are prepared to invite TENDERS for the ENGINEERING WORK for the COMPLETION of the BATHS.

Firms wishing to Tender can see the plans and specification showing the extent of the work at the Architect's Office, Town Hall, Spa-road, S.E., on application to the Borough Engineer, or at the Consulting Engineer's Office, Mr. W. M. Binny, A.M.I.C.E., 39, Carlton-road, Putney, S.W., before sending in their names and qualifications by Noon, April 21st, 1926.

The Council will select a limited number of firms to Tender, which Tenders are to be in by May 10th, 1926.

Selected firms will be provided with a set of plans and specifications and form of Tender upon payment of a deposit of £2, which deposit will be returned on receipt of a bona fide Tender accompanied by the return of the above plans, specification, &c., properly filled in.

FREDK. RYALL,
Town Clerk.

Town Hall, Spa-road, S.E. 16,
April, 1926. 2161

Rochester and Chatham Joint Sewerage Board.

MAIN OUTFALL SEWER AND DISPOSAL WORKS.
CONTRACT NO. 5.
TO IRONFOUNDERS.

The Board is prepared to receive TENDERS direct from ironfounders for the SUPPLY and DELIVERY at Rainham Station, near Chatham, Kent, of about 2530 TONS of CAST IRON PIPES and SPECIALS.

The Pipes and Specials will be 42in., 36in., 33in., 32in., 24in., 18in., 12in., 9in., 6in., and 3in. diameters, and will be mostly British Standard Spigot and Socket Class.

The Pipes and Specials are required in connection with the Board's scheme of sewerage and sewage disposal, which is approved for grant by the Unemployment Grants Committee, and that Committee has laid down as a condition that all contracts for or incidental to the works are to be placed in Great Britain.

The Board will require that all goods shall be of British production and manufacture.

Quantities, form of Tender, specification and conditions of contract may be obtained on and after the 19th April from the office of the Engineers, Messrs. W. H. Radford and Son, Chartered Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which sum will be returned on receipt of a bona fide Tender and the return of the quantities, &c.

Sealed Tenders, endorsed "Contract No. 5—Ironwork," to be delivered to me at my office, as under, on or before the 29th May, 1926.

The Board does not bind itself to accept the lowest or any Tender.

By Order,
E. W. WATKINS,
Clerk to the Board.

13, New-road, Chatham, Kent,
April 12th, 1926. 2145

The South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. CARRIAGE FITTINGS.
2. SCREWS, BOLTS, NUTS, &c.
3. STEEL TYRES for LOCO. ENGINES and TENDERS.
4. STRUCTURAL STEEL WORK.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Carriage Fittings," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 23rd April, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of Specifications Nos. 1 and 2, and of 10s. for each copy of Specifications Nos. 3 and 4.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 5, Victoria-street, Westminster, S.W. 1.

W. B. REYNOLDS,
For Managing Director.

91, Petty France, S.W. 1,
8th April, 1926. 2163

Uxbridge Urban District Council.

TENDER FOR CENTRIFUGAL PUMPS.

The Council are prepared to receive TENDERS for TWO CENTRIFUGAL PUMPS driven by Electric Motors, with a capacity of 80,000 gallons each per hour, to be fixed at their Sewerage Works, Uxbridge Moor, Uxbridge, Middlesex.

Particulars to be obtained from the Council's Surveyor, Mr. Wm. L. Eves, 54, High-street, Uxbridge.

Tenders, endorsed "Tender for Pumps," to be sent to the undersigned not later than Ten o'clock on Tuesday, the 27th April, 1926.

No Tender will be necessarily accepted.

H. M. BLACKWELL,
Clerk.

Council Offices :
109, High-street, Uxbridge,
14th April, 1926. 2136

Port of Bristol Authority.

The Bristol Docks Committee REQUIRE the SERVICES of a JUNIOR ELECTRICAL ENGINEER. Salary about £23 per month.

The duties will be to assist in the supervision of the repairs and maintenance of the electrical installation at the Avonmouth Docks, which includes electric motors on the grain machinery, cranes and general plant, electric lighting and underground cable system, with the various distribution switchboards, &c.

Applicants are required to state their age, training, previous employment, present position, and present or most recent salary.

Applications should be received by the Chief Engineer not later than Monday, the 3rd day of May, and should be accompanied by copies of three most recent testimonials. The appointment will be held during the pleasure of the Docks Committee.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol Authority.

Chief Engineer's Office,
Avonmouth Docks,
April, 1926. 2154

River Tees.—The Tees Conservancy.

COMMISSIONERS invite APPLICATIONS for the APPOINTMENT of ENGINEER, who will be required to devote the whole of his time and attention to the duties of the office; no private practice or the holding of any other appointment will be permitted.

Candidates must have had practical experience in carrying out the various works appertaining to Rivers and Estuaries, particularly the Construction and Maintenance of Breakwaters, Reclamation of Tidal Foreshore, and the latest types of Heavy River Moorings.

The successful candidate will be required to commence duties on the 1st October, 1926, and to join the Tees Conservancy Superannuation Fund.

Applications, stating professional qualifications, age, experience and salary required, accompanied by copies of three recent testimonials, addressed to the undersigned and endorsed "Application for Engineer," will be received on or before the 28th April, 1926.

JOHN H. AMOS,
General Manager.

Board Room, Middlesbrough,
7th April, 1926. 2113

PUBLIC NOTICES

City of Chichester.

WATERWORKS PUMPING STATION.

The Corporation REQUIRE IMMEDIATELY a SECOND ENGINEER and MECHANIC at the above Works. Wages £2 5s. per week, with house, rates, and coal.

Applications, in own handwriting, stating age, with full particulars of experience (Suction Gas and Steam Engines or Electrically Driven Centrifugal Pumps, and General Repairs), and copies of testimonials, to be sent to the undersigned.

(Sgd.) FRANK J. LOBLEY, A.M. Inst. C.E.,
City and Water Engineer.

Chichester, 8th April, 1926. 2135

Dublin Corporation Waterworks.

WORKS MANAGER REQUIRED.

The SERVICES of an experienced WORKS MANAGER are TEMPORARILY REQUIRED by the Commissioners for the County Borough of Dublin, to Take Charge of the Laying of about 7 Miles of Water Main, mostly 24in. in diameter. Part of the main is to be laid with cast iron pipes, concrete lined, and part with steel tubes, bituminen lined. It is estimated that the work will last about 18 months. Pay £7 per week.

Further particulars can be obtained from Mr. M. A. Moynihan, Acting Borough Surveyor, 38, Castle-street, Dublin, to whom application for the position should be forwarded not later than Wednesday, 5th May, 1926, at Twelve o'clock Noon.

JOHN J. MURPHY,
Town Clerk.

City Hall, Dublin,
12th April, 1926. 2148

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

Wanted at Once, Reliable INSPECTOR, with good experience in Reinforced Concrete Construction and Pile Driving.—Write, stating age, pay required, full details of past experience, and how soon could start work, with copies of testimonials, to RESIDENT ENGINEER, Harbour Improvement Works, States Office, St. Peter Port, Guernsey. 2172

WANTED by a Leading Boiler Insurance Company, additional BOILER INSPECTORS. Applicants must be practical engineers with technical training, holding a First Class or Extra First Class Board of Trade Certificate, capable of making accurately dimensioned sketches of all classes of steam boilers and writing clear reports on condition. Commencing salary £260 per annum.—Address, 2157, The Engineer Office. 2157 A

WANTED by Railway Wagon Building Firm, an ASSISTANT WORKS MANAGER. Applicant to have had experience in handling labour, works progress, steel wagons, and some knowledge of engineering. South Wales. State salary proposed.—Address, 2088, The Engineer Office. 2088 A

WANTED, ENGINEER, 28/32 Years, Educated, technical and workshop training, experience of high production methods, modern labour-saving devices.—Address, giving particulars of education, training, and experience, 2129, The Engineer Office. 2129 A

WANTED, INSPECTION SUPERINTENDENT for mechanical side of large firm of Commercial Motor Vehicle Manufacturers, capable of controlling all inspection work on component parts and the testing of units and finished chassis. Must be good organiser, with first-class experience.—Address, stating age and salary required, 2075, The Engineer Office. 2075 A

ASSISTANT ENGINEER and SURVEYOR REQUIRED for Road and Sewer Work on New Housing Estate. Salary (on temporary staff) about 4½ to 5½ guineas a week.—Application to be made on form to be obtained from CHIEF ENGINEER, The London County Council, Old County Hall (Room 40), Spring-gardens, S.W. 1. 2182 A

CONSULTING ENGINEER and MANUFACTURER has an OPENING in his London Office for a PREMIUM PUPIL. Must have a good general education, some knowledge of drawing an advantage. Would be given a thorough training with a view to a permanent post when proficient. Interview by appointment.—Address, 1986, The Engineer Office. 1986 A

CONTRACTOR'S ASSIST. for Small Factory Buildings, London; outdoor exp. essential; £250 p.a. —Address fully, P1813, The Engineer Office. P1813 A

ENGINEER WANTED, to Take Charge of London Shop well equipped for small repetition work and develop output. Contracts in hand cover six months' work. Must be able to influence at least £5000 to be invested in share in limited company. Principals only need apply.—Write, Box 1987, Sells, Fleet-street, E.C. 4. 2108 A

MECHANICAL ENGINEER DESIGNER REQUIRED for large Electrical Switchgear Factory. Must have initiative and sound knowledge of mechanical movements and design for quantity production. Shop experience essential, electrical knowledge desirable, but not imperative. State age, full particulars, and wage required.—Address, 2191, The Engineer Office. 2191 A

PLANNING AND PROGRESS MAN.—MAN REQUIRED in Planning Department. One who has had considerable experience in progressing work in a shop manufacturing complicated mechanisms on repetition lines. Progressive position for suitable man. —Address, stating age, experience, and salary required, 2190, The Engineer Office. 2190 A

REPRESENTATIVE REQUIRED by an Old-established Firm to travel country in line of High-class Machine Tools, including Gear-cutting Machinery. An existing connection absolutely essential amongst motor car manufacturers and engineering firms who undertake precision work.

Application should indicate range and quality of connection (for which adequate salary will be paid), together with full particulars, age, salary required, &c. Address in first instance, 2166, The Engineer Office. 2166 A

REQUIRED as ASSISTANT to MANAGING DIRECTOR of large Engineering Works near Manchester, a highly qualified ENGINEER, combining good commercial training and experience of factory management and production. Age 30-40. Only highly qualified applicants will be considered. Good salary and prospects for first-class man.—Write, Box 595, Sells, Fleet-street, E.C. 4. 2181 A

REQUIRED for RAILWAY IN BRAZIL :—ASSISTANT LOCOMOTIVE SUPERINTENDENT and WORKS MANAGER. Age not over 32, salary about £850 p.a. on 3 years' contract, passage provided. Good theoretical and practical training, including D.O. and experience in works management; able to control staff and learn Portuguese.

DISTRICT ENGINEER. Age not over 30, salary about £450 p.a. on 3 years' contract, passage provided. Good theoretical and practical training, particularly in Running Department; would have charge of light and medium overhauls; able to control staff and learn Portuguese.

Write, giving full particulars education, training, experience, age, to Box M.B.T., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 2162 A

STRUCTURAL STEEL WORK.—Thoroughly Experienced and competent DRAUGHTSMAN REQUIRED (London district), capable of designing and detailing all classes of Structural Steel Work for Buildings and carrying through contracts without supervision. State full experience, age, and salary required.—Address, 2167, The Engineer Office. 2167 A

SITUATIONS OPEN (continued)

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

English Optical Glass.

IT was none too soon that on Monday last Sir F. Dyson, the Astronomer-Royal, made in his presidential address to the Optical Convention, which is at present holding its meetings in London, an appeal for the recognition of the merits of English optical glass. For, perhaps, a generation past we have been brought up on the idea that for quality we must go to the Continent for glass, and that for economy's sake we must import our glass wares from overseas. Nevertheless the British fine glass industry has prospered, more or less, especially in the Birmingham district, for at least more than one generation. It only required the impetus of the demand created by the late war for optical instruments, to energise our latent forces, with the result that, as Sir Frank explained, we produced in 1918 95 per cent. of our requirements, as compared with only 10 per cent. in 1912. At the same time the industry has been developed to such an extent that not only is the quantity, but also the variety of glass required by it, produced in this country. That is, of course, only the natural result of the effects of demand and supply. Our glass manufacturers have been, for instance, pre-eminent in the production of lenses for navigational lights from time almost immemorial, and it was a natural outcome that they should turn their abilities to smaller, though no less intricate work, in times of stress, so that British telescopes, binoculars and similar instruments are now unexcelled. There is, however, a branch of the glass industry to which Sir Frank Dyson did not refer, which will more directly appeal to the English engineer on account of his intimate association with the cheapening of production. We refer obviously to the manufacture of glass bottles in this country, an industry which has been more or less monopolised by the Americans, and concerning which we have already published some particulars. Since the appearance of our last article on that subject we understand that the British machine has broken all previous records for output, and that there are now under construction two more highly developed machines, which, it is hoped, will be able completely to eclipse that which we have already described.

Reorganisation at Crewe.

IN a recent statement issued by the London, Midland and Scottish Railway further particulars are given concerning the alteration at the Crewe Locomotive Works, to which we referred in these columns nearly a year ago. The main improvements concern the new erecting shop and the steel works, although certain other parts of the works are to be reorganised and brought up to date. A new locomotive erecting shop, 850ft. long by 193ft. broad, is to be erected, and it will be served by two 50-ton and two 10-ton high-speed cranes in each of its three bays. In the steel works two 70-ton and two 45-ton furnaces with mechanical charging gear will be built. They will be gas fired, the gas being generated in six revolving-grate gas producers of a new American type. A vertical plate-bending press is also to be installed, and the use of compressed air in the works will be extended by the provision of two 2000 cubic feet electrically-driven air compressors. Considerable improvements, we learn, will also be made to the gasworks, which supply gas to the town as well as to the works. Modern horizontal retorts are to be put in, with new purifying and exhausting plant and a new gasholder of 1,000,000 cubic feet capacity is to be built. New mains of a considerable mileage are also to be laid. When the alterations are completed, the Crewe works, which will extend over an area of 160 acres, will be the largest of their kind in the country. They will have an output capacity of about 100 new locomotives, 1500 heavy repairs and overhauls and 350 new boilers per annum.

The Late Herr August Thyssen.

BY the death of Herr August Thyssen, the recognised head of the many Thyssen undertakings, Germany loses one of her foremost industrialists. He died last week at Mülheim, in the Ruhr, at the advanced age of eighty-five. Thyssen was a pioneer worker, who early saw the immense possibilities of the coal, iron and steel industries of the Upper Rhineland and Westphalia, and who in a little over fifty years did perhaps more than any other single man to build up the Ruhr industry, as we know it to-day. He created and personally directed an undertaking which embraced all the stages, from the winning of the raw materials to the manufacture of engineering plant and machinery. It was in 1867 that young Thyssen left his father's forge at Eschweiler, near Aix-la-Chapelle, to found the small firm of Thyssen, Foussoul and Co., in Duisburg. In 1871 the factory of Thyssen and Co. was started on a farm at Styrum, near Mülheim, for the manufacture and sale of hoop iron and other fine iron products. The business was built up in the teeth of financial depression, but in thirty years August Thyssen had secured his world markets. Meanwhile, steel making, plate rolling and machine manufacturing were added, as well as important coal mining interests. An important development was the Thyssen system of cleaning blast-furnace gas and the introduction of large gas engines, but steam turbine generating plant, power-house and colliery equipment, as well as the Holzwarth gas turbine, were other no less important activities of the firm. In pre-war times Thyssen had large iron ore interests in French and German Lorraine, and in France at Caen and Cherbourg. During the war the home works, which included collieries, iron mines, blast-furnaces, both Thomas and Siemens steel plant, rolling and plate mills, welding and constructional plant, and also machine shops, were extended and improved. In the difficult post-war years August Thyssen remained at the head of his firm. In spite of failing health he continued to the last to direct and control the vast interests with which his name will always be identified.

Vickers Limited.

EFFECT has now been given to the proposals of the expert investigators and representatives of the shareholders with regard to the financial reorganisation of Vickers Ltd., and the names of the members of the reconstituted board of directors are announced. A new office has been created, that of president of the company, to which Mr. Douglas Vickers has been elected. General the Hon. H. A. Lawrence is the chairman of the new board, which includes as ordinary members Sir David Yule, George R. T. Taylor, Sir Edmund Wyldbore Smith, and Mr. M. Webster Jenkinson and the Rt. Hon. Lord Invernairn. Other full members of the board, who by reason of their special knowledge are also members of one or more of the three subsidiary management boards, are Sir Vincent Caillard, Commander C. W. Craven, Sir A. Trevor Dawson, Sir George Buckham, and Mr. Vincent C. Vickers. The members of the management boards are as follows :—Industrial : Mr. M. B. U. Dewar, Mr. W. F. Sadler, Mr. Bernard D. F. Docker, Mr. Alexander Spencer, Sir Philip A. M. Nash, and Mr. T. L. Taylor ; armaments and shipbuilding, Sir George Buckham, Commander C. W. Craven, Sir A. Trevor Dawson, and Mr. O. H. D. Vickers ; finance, Sir Vincent Caillard, Mr. Vincent C. Vickers, and Mr. A. Cartwright. These three boards are interlocked with each other and the main board by the appointment of Mr. Webster Jenkinson to all three management boards, Sir David Yule to the industrial and finance boards, and Sir E. Wyldbore Smith to the industrial and Mr. George R. T. Smith to the armaments and shipbuilding board. The advisory experts have consented to continue to act temporarily in an advisory capacity to the main board in connection with the internal reorganisation of the company, which is now taking place.

The Rugby Wireless Station.

IN reply to a letter from the Empire Press Union, the Postmaster-General states that the Rugby wireless station is at present being used for broadcasting the British official wireless news messages, twice daily, and for transmitting private telegrams to ships beyond the range of the normal ship and shore stations in this country. The use of the Rugby station for the latter purpose makes it possible to offer a direct service at any point on the high seas to ships fitted with suitable receiving apparatus. On April 18th the Rugby station is to take over the Marconi Press service to ships, which has hitherto been conducted from the Leafield Station at Oxford. Facilities are being offered by Rugby for the transmission of messages containing news and commercial intelligence for multiple reception in the Dominions, Colonies, and in foreign countries. As is well known, the Rugby Station is also being used for experiments in telephonic communication with the United States. Very promising results continue to be obtained, but the service is still in the experimental stage, and some time will probably elapse before a commercial service becomes practicable. The beam stations at Bodmin and Bridgwater, now being erected for the Post Office by the Marconi Company for communication with Canada and South Africa, are expected to be completed early in May, and the corresponding stations in Canada and South Africa about the same time or shortly afterwards.

Naval Shipbuilding in Russia.

REPORTS of naval shipbuilding activity in Russia have been heard at frequent intervals during the last few years, but the actual amount of new tonnage in hand appears to be small. It is probable that the difficulties which have notoriously delayed the completion of the Government fleet of merchant vessels are responsible in even greater measure for the slow progress of naval construction. From a reliable German source we learn, however, that the Soviet naval section has definitely ordered ten submarines and fifteen coastal motor boats for the protection of Leningrad. The submarines, being designed for cruising in the Gulf of Finland, will be boats of only 130 tons, with a radius of 200 to 300 nautical miles. Part of the material will be purchased abroad, but the Obuchoff Works will supply the armament, and the boats are to be assembled and launched at the Neva Yard. They are due for completion by the end of this year. The coastal motor boats are on the stocks at the "Red Shipbuilding Yard," formerly the Ochta establishment, and every effort is being made to hasten their completion. Their general design resembles that of the famous Thornycroft C.M.B.'s, a flotilla of which carried out a brilliant attack on Kronstadt Harbour in 1919, when two Russian battleships were torpedoed. This incident appears to have made a deep impression on the Soviet naval authorities. The Russian type of boat has an abnormally shallow draught and a very good turn of speed. In addition to this new construction, various units of the Baltic Fleet are undergoing repair.

Miners and Engineers.

THE public has been disturbed throughout the past week by the shadow of approaching troubles in the two great industries of engineering and coal mining. It will be recalled that some time ago the colliery owners expressed their acceptance of the Report of the Royal Commission on the Coal Industry, whilst the Miners' Federation from the first rejected some of the recommendations. On Tuesday last the Federation issued its considered reply. Substantially it coincides with the attitude exhibited by the union in its recent fruitless discussions with the owners. The fundamental point turns on the question of wages, for the miners will not hear of a reduction nor will they consider any rearrangement by districts of the minimum wage. At the moment matters are at a deadlock, and in some quarters it is believed that the object of the Federation was to force the Cabinet to take up the question. In that it appears to have succeeded, for the Prime Minister is now taking a direct part in the negotiations. It hopes, thereby, to get the subsidy renewed despite the recommendation of the Commission. The position in the engineering world is nearly as precarious. The employers made it quite clear at the time of the Hoe strike that in the event of local strikes for increased wages they would call a general lock-out. They have also made it clear that the condition of the industry is such that an increase of wages by one pound a week is impossible. Yet the A.E.U. and other unions continue to press the claim, and are now threatening to make the demand by districts and to strike if it is refused. Whilst both these events have threatening aspects, it must not be too hastily assumed that the country is on the verge of either a mining or an engineering strike of vast dimensions. We have already alluded to the probable intention of the miners, and it is only necessary to say with regard to the engineers that the leaders are following a proper constitutional course, and that discussions and negotiations continue.

Institution of Fuel Economy Engineers.

WE are able to announce that an Institution of Fuel Economy Engineers has been established in the interests of those engineers who are dealing with fuel problems in their various aspects. The primary objects as set forth by the Council are :—To promote the science and practice of Fuel Economy Engineering in all its branches, and to give encouragement to the use of inventions and an impulse to methods likely to be useful to members ; to enable engineers and others interested in the production, preparation, use, and combustion of fuel to meet and correspond ; to facilitate the interchange of ideas respecting improvements in the various branches of Fuel Technology, particularly in regard to the economical preparation and combustion of fuel for industrial purposes ; and to publish information on such matters. Membership of the Institution—which has arisen out of the so-called Nottingham group, and must not be confused with the Institution of Fuel Technology—automatically carries with it membership of the Institution of Fuel Economy Engineers, Ltd, the liability of members being limited to the nominal—maximum—sum of five shillings. The annual subscription payable by a full member of one or more of the recognised kindred Institutions is reduced from three to two guineas, and at present there is no entrance fee. Members enrolled up to September 30th will be shown on the register as Founder Members. The Council further draws attention to the entire independence of the Institution and the importance of local sections in industrial centres. The secretary is Mr. H. L. Pirie, 26, Victoria-street, London, S.W. 1.

An Aeroplane Collision.

IT is with deep regret that we chronicle one of the most serious aeroplane collisions which have occurred in the Royal Air Force since the war. The accident occurred at Henlow Aerodrome, in Bedfordshire, on Saturday, April 10th, shortly before eleven o'clock, in the course of routine work. A Vickers-Vimy five-seater bombing machine flown by Flying Officer C. V. Lacey, with three aircraftsmen, was returning to the aerodrome after being engaged on testing parachutes. Its purpose was, it is supposed, to take up another leading aircraftsman for a live drop with one of the parachutes already tested. As the machine was descending an Avro two-seater flown by Flying Officer W. Scott without an observer left the ground. The two machines, although both apparently under control, collided at a height of about 300ft. in the air. They interlocked and crashed in a ploughed field near the aerodrome and all the occupants were killed.

Some Aspects of Friction.

By W. A. BENTON.*

No. II.†

Let us now briefly consider the state of knowledge regarding the friction of solid bodies after Morin had published the results of his researches. All the facts of the essential phenomena had been discovered, the knowledge so acquired had been systematised, and Amontons' law had been established on a broad basis of irrefutable experimental testimony. In modern symbols Morin wrote the principal equation thus:

Let μ be the coefficient of friction.

Let P be the pressure normal to the contacting surfaces.

Let μ P be the tangential force of friction.

Then the *resultant reaction* is $P\sqrt{1+\mu^2}$ and this resultant makes with the common normal an angle β, of which the tangent is μ, or $\tan\beta = \mu$. He called the angle β the "angle of friction."

Early in the nineteenth century general expressions had been found for the "work of friction"—meaning, of course, the work wasted in overcoming it. In fact, by this time, the mathematicians had really got to work.[1]

An endeavour will now be made to indicate very briefly the present position regarding surfaces nominally unlubricated or sparingly lubricated, in both of which friction is in accordance with Amontons' law; that is, it depends on the total pressure, and is independent of area and velocity.

The classical experiments of Beauchamp Tower, in 1883, showed that a fully lubricated half-bearing resting on a revolving shaft was completely separated from the shaft by a thin film of oil under pressure—"so that," to quote Dr. Stanton, "the total fluid pressure in the direction of the load was numerically equal to the load." Tower's results gave Osborne Reynolds the basis for his epoch-making mathematical investigation—an investigation which resulted in the hydrodynamical theory of lubrication, and afterwards led to the simplification and extension of that theory by Sommerfeld, and to the remarkable development and practical application of it by Michel.

Hydrodynamical lubrication gives us conditions of friction wholly different from those we have hitherto been considering. A fully lubricated bearing exhibits a type of friction which appears to depend almost entirely on the viscosity of the lubricant, on the relative velocity of the parts, and on the area of the bearing surfaces. These factors are inevitable if we are dealing with a film obeying ordinary hydrodynamic laws. We know that the film of fluid in actual contact with each of the metal surfaces is either quite stationary in relation to its own metal surface, or has an extremely slow movement. Hence journal and bearing, when in relative movement, must be shearing the film—that is to say, overcoming its internal friction; and the force required to do so must be some function of the area, that is of the amount of shearing done in any extremely small space of time, whatever the velocity. It must also depend upon the velocity, since that factor determines the rate at which the resistance to shear is overcome, no matter how small or how great may be the area of the surfaces which cause the shearing. Obviously, too, pressure will only come into the equations in so far as it may affect the viscosity of the fluid. As a matter of fact, increase of pressure increases the viscosity, while rise of temperature, as is well known, tends to reduce it.

Since the theory and practice of hydrodynamical lubrication was established, there has been a tendency in some quarters to regard it as accounting for all lubrication with which we have to deal in engineering practice. The author, however, holds with the majority of practical engineers that hydrodynamical lubrication of the Reynolds type—an important reservation—will only account for a portion of the facts familiar to us in daily practice; and that, whether there be such a thing as "boundary lubrication" or not, as defined by mathematical physicists—lubrication in which the lubricating film is supposed to be only one or two molecules in thickness—we do often deal, as a matter of fact, with lubrication that conforms in the main to Amontons' law. He believes that, whenever the friction depends on the nature of the metals rather than on the abundance of the lubricant, or on the chemical nature of the lubricant in cases in which the film itself is known to be extremely thin, in all these cases we are dealing not with hydrodynamical friction but with friction approximating to the Amontons' type. To the above he adds all those cases in which it is evident that the velocity of relative movement of the pair of parts has little or no effect on the total friction, but in which the total pressure between the parts does markedly affect the total friction. These cases include the majority of greased or poorly lubricated pairs, and the majority of reciprocating pairs such as cross-heads and slides, trunk pistons and cylinder walls, and the like.

A large number of engineers and physicists hold the views just enunciated, in spite of the fact that there appear to be authenticated instances of hydrodynamical lubrication when the least thickness of the permanent unbroken film has certainly not exceeded, say, the fifth part of one-thousandth of an inch, and even in spite of Dr. Stanton's claim to have obtained hydrodynamical lubrication with a film not thicker than one twenty-thousandth of an inch.[2]

The work of various physicists and physical chemists from Langmuir to Hardy, has gone to prove that the surfaces of all metals are covered with adherent films, for the most part consisting of fatty matter attracted to the interface of metal and air because their presence lowers the potential energy of the metallic surfaces.[3] These films can be cleaned off metal faces by elaborate and difficult laboratory methods, and it is found that when so cleaned the friction between the clean dry surfaces—for these experiments must take place in absolutely dry air—is generally enormously increased. The coefficient occasionally becomes eight times as great as for the same surfaces in their natural condition.

It is believed that frictioning surfaces are only really in contact when these films have been by some means removed or reduced, as, for instance, under excessive conditions of heat and pressure. The "seizing" of a bearing is produced by the sudden coming into contact of unprotected surfaces—surfaces cleaned, and so possessing an enormously high coefficient of friction. We have definite evidence of the

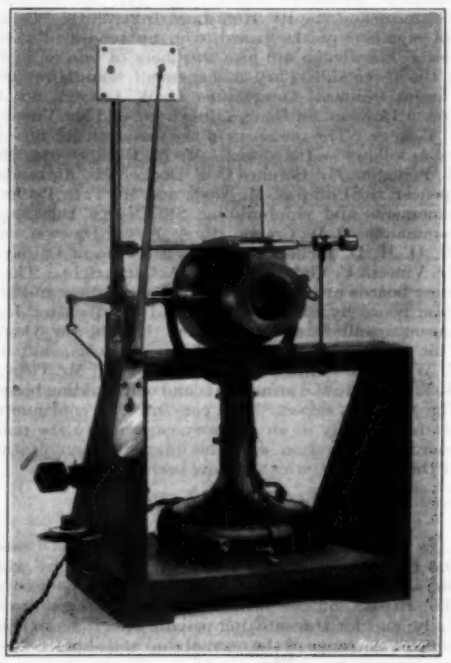

FIG. 3—APPARATUS FOR DEMONSTRATING KINETIC FRICTION

extraordinary manner in which the mere presence of a spot of a fatty acid, or glyceride of a fatty acid, will at once "contaminate" a cleaned glass or metallic surface brought near it. Such a surface, according to accredited observers, becomes almost immediately covered with an incredibly thin film of the fatty material; and its coefficient of friction falls with corresponding rapidity to the familiar ratio characteristic of that surface when in contact with another given surface.[4]

The instrument shown in Fig. 3 consists of a small electric motor adapted to rotate a pulley on which cylindrical sleeves of various metals can be secured. A saddle and frictioning shoes turned to fit the curvature of the sleeves are provided, and there are means for applying suitable loads. A weight pan and indicator finger are added, so that the force of friction can be conveniently measured. The instrument was designed by the author as a lecture-table device to make certain phenomena visible to an audience.

As the rotor is set in motion and the force of friction balanced off, increase in speed never causes an increase in the frictional pull, but occasionally leads to a marked reduction. This result may in part be caused by the entrainment of air between the surfaces. A more interesting demonstration of the difference between the coefficients of kinetic and static friction can, however, be given by overloading the weight pan so as to cause it to draw the saddle and its frictioning segment back against the stop. If the current is then cut off it will be found that the moment before the rotor comes to rest the force of friction appears to be suddenly increased, and the saddle is carried sharply forward in the direction of rotation until it contacts with the forward stop. A fraction of a second later, when the motor comes to rest, the weight pan pulls the saddle violently back. The author does not think that entrainment of air can entirely account for this interesting phenomenon.[5]

It can easily be shown that the total friction varies directly with the total load, but a more interesting experiment is to lubricate one of the sleeves and its corresponding frictioning segment with oleic acid. With the surplus oil wiped off, the now reduced coefficient can be measured. On attempting to wipe off every trace of the lubricant, one finds that the coefficient of friction remains for a time practically unchanged, showing how incredibly thin is the fatty-acid film which is required to effect perfect boundary lubrication—lubrication in strict accordance with Amontons' law. By means of strong ammonia it is possible momentarily to cause an increase in the coefficient, due to the washing off and partial evaporation of the fatty-acid film.

There is another effect which is worth observing. Let a cast iron sleeve and a cast iron segment be fitted to the instrument, and the frictional pull balanced off. On bringing a small horse-shoe magnet near the two pieces in such a position that the magnet poles bridge across a portion of the interface, a marked increase in the frictional moment will be noticed—an increase too big to be accounted for on the basis of increased pressure between the parts, or of eddy currents set up in the rotor. This effect has been made use of by Dr. N. W. McLachlan for operating relays, syphon recorders and the like in high-speed radio-telegraphy,[6] and was first observed by Professor Dolbear in America, as early as 1879.[7] The phenomenon is very similar to the Johnsen-Rahbek effect, in which an extraordinary change in the friction between a band and a rotating cylinder of semi-conducting material is caused by varying the electrostatic stress between the parts.[8] This effect can be used to work a loud speaker, just as Edison used the same effect to do similar work more than forty years ago. A widely accepted explanation at that date was that the minute speech currents caused a varying, microscopically small, decomposition of the moisture on the disc of damp chalk or lithographic stone used as a rotor, and thus caused the frictional coefficient to vary.

Some conclusions and suggestions to which the author has been led by a lengthy study of the friction of nominally unlubricated and semi-lubricated bodies will now be stated.

No explanation of the phenomena covered by Amontons' law can be accepted to-day which is based on the old doctrine of asperities. Beilby, proving Rayleigh's contention, has shown that when we polish a surface, a "flowing" takes place, and we obtain under the influence of surface tension a surface that can only be likened to the surface of a true fluid. Hence the "asperities," if they exist, cannot exceed molecular dimensions. Various theories of tractions and rotations, of elastic or rupturing displacements, and of oriented surface molecules, have been put forward by Deeley and by Hardy, and the latter has shown great ingenuity in stating a case for alternative forms of this general hypothesis. The fact that, when a glass lens is pressed into actual—not seeming—contact with a flat surface, and drawn across it, the track is found to be permanently doubly refractive, is taken as a proof that in such cases a permanent change of orientation has taken place. An obvious comment on this statement is that the stress has produced an orientation in an otherwise optically indifferent super-cooled surface. The phenomenon is, nevertheless, very significant.

We next come to the one outstanding fact in respect of ordinary contaminated smooth surfaces, or smooth surfaces artifically contaminated by fatty-acid molecules. It would appear that we must accept as an established fact that complete lubrication may occur in certain special cases when the film is approximating to molecular dimensions, though there may be and probably are "pilings-up" of molecules at particular spots. Granted these conditions, Amontons' law can be reasonably explained—but only for the given conditions.

As regards the partially lubricated surfaces met with in engineering practice, the conditions are generally wholly different from those obtaining in such cases, and the famous law holds good for wholly different reasons. The following explanations, among others, have been suggested:—(1) The "high-spot" hypothesis: When two surfaces are in contact, however truly they may be matched, and however certain it is that there are no "asperities" on the surfaces greater in size than the order of molecular diameters, it is reasonable to assume that different portions of one surface are not all situated at the same normal distance from the corresponding parts of the other surface with which they are supposed to be in contact. Assuming that the diameter of an average molecule is about one hundred millionth part of an inch, it will be seen that there must be comparatively great differences in nearness of approach of different portions of frictioning surfaces. It can

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* Head of Research Department, W. and T. Avery, Ltd., Birmingham. These articles contain the substance of a paper read before the Midland Branch of the Institution of Mechanical Engineers, Birmingham, October 15th, 1925.

† No. I. appeared April 9th.

[1] Thus: Total work in time t is given by $\iint \omega \mu p \frac{ds}{dt} dt$, where ω is total area.

[2] Stanton, Ninth Thomas Hawksley Lecture, 1922 (I.M.E.).

[3] Hardy in Fourth Report on Colloid Chemistry.

[4] Hardy cites an imperceptible film of tripropylamine as thus by its mere neighbourhood reducing the friction of a clean plate from 0·94 to 0·25.

[5] In this connection see Charron, "Rôle Lubrifiant de l'Air dans les Frottement des Solides." Paris: C. R. Acad. Sc, 150 1910.

[6] Institution of Electrical Engineers, Wireless Section, April 11th, 1923.

[7] Mr. A. A. Campbell Swinton, *Engineering*, April 20th, 1923.

[8] For some particulars regarding the Johnsen-Rahbek effect, see The Engineer for June 3rd, 1921 and February 22nd, 1924.

easily be shown that wherever the surfaces approach closely together, lubricant will be accumulated by surface tension. Such discrete and numerically limited systems would tend to resist deformation by tangential stresses, and would also oppose an increase of normal pressure, which by bringing the parts yet closer together, would tend to increase the surface-tensional components drawing the fluid between the surfaces. Hardy and others claim that under these conditions the friction would conform to Amontons' law. One can only agree provided that reciprocating movements to the exclusion of continued rotary or one-sense movements are intended. Granted, however, that means are provided for continually renewing or re-establishing the conditions, slow rotary motion should be possible. Theoretically, however, this type of lubrication will break down as soon as the rate of rupture of the discrete systems exceeds the rate of establishment of new and neighbouring systems by surface tensional forces. It is possible that this "high-spot" hypothesis is sufficient to account for the slow rotation of grooved but inadequately lubricated or grease-fed bearings under heavy loads; but the author does not think that it can be held to account for more than a fraction of the practically satisfactory cases of this type of lubrication familiar to engineers.

(2) The white-metal bearing and its extraordinary ability to deal with heavy loads has got to be explained, and it is evident that here we are dealing with some very intimate physico-chemical relationship between the molecules of the metal and molecules of the lubricant. This is now generally admitted. The author has no suggestion to offer as a substitute for the "one-molecule" orientation hypothesis. But even granting that this hypothesis may be extended to pilings up of molecules, making a film in places several or many molecular diameters in thickness, it seems incredible that this theory alone can account for familiar facts in engineering practice.

(3) A possible explanation of some cases has occurred to the author on observing that the heavier fatty-acids—which, as a result of Hardy's laborious researches, we know increase in lubricating power in direct proportion to their molecular weight—are all insoluble in water. We know also that they all tend to spread on the surface of water. Now, water is always present on metal surfaces, and always present with fatty-acid films, especially if glycerides or other alcoholic esters of the fatty acids are in use, as is generally the case in practice. Let it be supposed that minute globules of water covered with a lubricant are formed under the action of cohesive surface-tensional forces. Even if we admit, as we must, that the oil will lower the surface tension of the globules, such minute globules once formed would oppose a very great resistance to deformation, and each deformed ball would resist tangential rolling forces in a degree proportional to its deformation and to the increase in its viscosity due to the pressure deforming it. The author is not at all sure that it is possible to prove that such globules could be formed, but it is worth noticing that once granted they can be, or will be, formed under lubricating conditions, we have a state of affairs that will explain Amontons' law of friction for semi-lubricated surfaces, without resort to molecular dimensions.

There is one other suggested explanation of these puzzling phenomena to which reference appears necessary. Towards the close of his article on the "Theory of Lubrication,"[9] Professor Sir W. B. Hardy attempts to show mathematically that under certain restrictions, hydrodynamic lubrication may be found to give frictional effects in accord with Amontons' law. He considers the case of two parallel plane surfaces with fluid between, one surface having unlimited extent, and the other being of unlimited extent along the z axis, but limited at $x = a$ and at $x = b$. The two surfaces are squeezed together without tangential motion, thus squeezing out the fluid which will have zero velocity at the middle of the surfaces and greatest velocity at the ends. The motion will be resisted by the internal friction of the fluid, and as this friction is proportional to the velocity and equal and opposite to the pressure, the pressure is greatest at the middle and vanishes at the edges.

If there be tangential motion of velocity U on one of the planes, the fluid will be dragged along with it, and there will be a gradient of velocity in the fluid from U at the moving plane to zero at the stationary plane, the internal friction again being opposed by a pressure. Let the two parallel planes be at $y = o$ and $y = h$, and let the motion be everywhere parallel to x. An element of volume $(d\,x\;d\,y)$ is subject to the force $\eta\;(d^2\,u/d\,y^2)\;d\,x\;d\,y$, in which η is the coefficient of internal friction and u is the velocity in the direction of x. Since there is no acceleration, this force is balanced by that due to the pressure, namely, $(d\,p/d\,x)\;d\,x\;d\,y$, and therefore—

$$\frac{d\,p}{d\,x} = \eta\,\frac{d^2u}{d\,y^2}\,*$$

Hardy then proceeds to a series of integrations along lines suggestive of the methods of Sommerfeld and Michel. At the end of the fourth equation he points out that so far the motion is uni-dimensional, but that the equation is approximately applicable if h is variable, and always small, provided that the variations are not too abrupt.

In equation (4) we get—

$$\frac{d\,p}{d\,x} = -\frac{d\,\eta\,U}{h^3}\,(h - H).$$

In equation (5) the tangential traction exerted by the liquid on the moving plane is given by

$$\frac{P}{6\,\eta\,U} = \int_a^b \frac{x\,dx}{h^3} - H\int_a^b \frac{x\,dx}{h^3} \quad . \quad . \quad . \quad (5)$$

where P is the total pressure and H is the thickness of the film. The total friction F is given by—

$$\frac{F}{\eta\,U} = 4\int_a^b \frac{d\,x}{h} - 3\,H\int_a^b \frac{d\,x}{h^2} \quad . \quad . \quad . \quad (7)$$

Professor Hardy points out that comparing (5) and (7), we see that the ratio of the total friction to the total load ($F/P = \mu$) is independent of η and of U, and since the right-hand members of (5) and (7) are dimensionless, it is independent of the linear scale. He claims that this elimination of η (the coefficient of viscosity), and of U (the tangential velocity) from the evaluation of $F/P = \mu$, together with the disappearance of area, brings us "to Amontons' law from purely hydrodynamical considerations."

If the integrations will stand, and if—which is perhaps more open to question—the premises can be held to correspond reasonably with physical actualities, then the author is disposed to consider these equations as being of very great importance. The disappearance of superficial dimensions from the final equations may prove to be as significant for this particular problem as the famous disappearance of the term for pressure in Maxwell's equations for the viscosity of a gas.

[9] Hardy in Fourth Report on Colloid Chemistry.

* In the above expressions the author has written u for μ, which latter appears in the "Report," and is evidently a misprint, since the component of velocity in x direction must be intended.

Alternating-current Pressure Regulators.

No. I.

THE proposal to link up power stations on an extensive scale and to transmit and distribute alternating current more widely than hitherto should give rise, among other things, to an increased demand for alternating-current pressure regulators, such as induction regulators. Apparatus of this nature is employed for boosting interconnectors between power stations, for boosting feeders to compensate for pressure drop, and for regulating the voltage of rotary converters.

Years ago we published a series of articles on direct-current boosters which, of course, revolve, but whilst it is possible to utilise rotary alternating-current boosters, it is not usual to do so except on rotary converters. An alternating-current feeder booster might consist of a synchronous motor connected across the mains and coupled to an alternator connected in series with the line; but apart from the

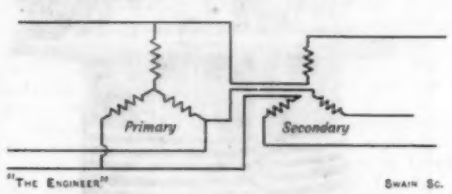


FIG. 1—CONNECTIONS FOR INDUCTION REGULATORS

fact that the efficiency of such an arrangement is low, it presents the disadvantage that it involves the use of two revolving machines, which are naturally more troublesome and costly to operate than a static piece of apparatus. A more simple and efficient and less costly arrangement is the series boosting transformer with adjustable tappings. Another efficient arrangement is the induction regulator, which is capable of giving fine voltage regulation. In construction and in theory it resembles an induction motor, with a primary polyphase exciting winding usually wound on the stator and a secondary or boosting winding wound on the rotor, the phase windings of which being open at both ends and connected in series with the feeders, as shown in Fig. 1. Normally the rotor is stationary, but it is capable of being tuned through a complete pole pitch for the purpose of varying the boost.

When the alternating-current pressure is applied to the primary winding a rotating magnetic field is set up in the ordinary way, and it produces an electromotive force in the secondary winding in exactly the same manner as when the rotor of an induction motor is at standstill. The phase of this induced electromotive force produced in any given part of the secondary winding relative to the electromotive force supplied to the primary winding depends on the relative position in space of the two windings. Let it be supposed that the stator carries the primary winding and that the rotor is situated so that the electromotive force generated in a particular phase winding is exactly in phase with the electromotive force in one of the supply mains; then it is obvious that if this particular secondary winding be connected in series with the feeder belonging to this phase the two voltages will be added together as shown in Fig. 2, where O A is the supply voltage, A B the secondary voltage, and O B the feeder voltage.

Under the condition indicated in Fig. 1 the induction regulator will give the maximum boost. If, however, the rotor be turned slightly in the same direction as the rotating field, the electromotive force induced in the secondary winding will be retarded in phase relative to the supply voltage and the feeder voltage will be reduced as indicated by O B in Fig. 3, the lines O A and A B representing the supply voltage and secondary voltage respectively as in Fig. 2. The

FIG. 2

FIG. 3

FIG. 4

feeder voltage is the vector sum of the supply voltage and the secondary voltage. On turning the rotor still more the feeder voltage is still further reduced, and when the feeder voltage is less than the supply voltage the regulator is said to buck, the maximum reduction in voltage being reached when the secondary voltage is directly opposite in phase to the supply voltage. The locus of the feeder voltage O B as the rotor is turned from the full boost to the full buck position—that is to say, through a pole pitch—is shown in Fig. 4. By moving the rotor still further the complete circle of secondary phase difference could be passed through, but in practice the movement of the rotor is usually limited to 180 electrical degrees, as that gives the full range of variation possible. On a four-pole regulator, this corresponds to only 90 deg. of angular movement, and it is therefore usual to lead the current into the rotor by means of flexible cables, thus avoiding the use of slip rings and brush gear. When the feeder current is very heavy it is often found advisable

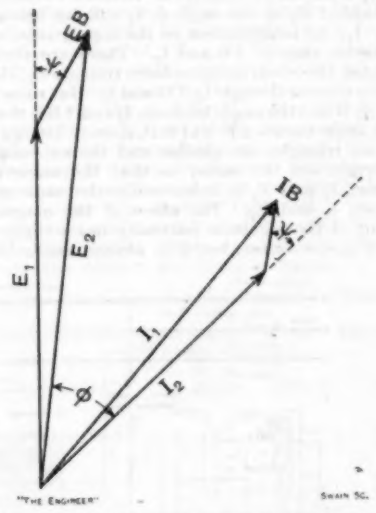


FIG. 5—VOLTAGE AND CURRENT DIAGRAM

to place the secondary winding on the stator, for in that way the heavier currents may be more easily dealt with. Of course, in this case the rotor carries the primary winding. The fact that an induction regulator can give its full boost in either a positive or negative direction enables the size to be reduced to one-half that which would be necessary if it could only boost in one direction, the main transformer ratio being selected so that the regulator bucks at periods of light loads.

As indicated in Fig. 4, except at times of maximum boost or buck there is a phase difference between the supply electromotive force and the feeder electromotive force. When the regulator is inserted in a feeder which forms part of a ring main or when independent regulators are used in parallel feeders, this phase difference is objectionable, as it gives rise to circulating currents, and it must be eliminated. This may be done by using two regulators, each having half the total capacity and operated simultaneously. The secondaries are connected in series and arranged so that the phase shift of one neutralises the phase shift of the other. In the case of an independent feeder, however, the phase shift has no appreciable effect. If the magnetising current and losses of the regulator are neglected, the power factor is unchanged by the regulator, as shown in Fig. 5, where E_1 repre-

sents the supply voltage, E B the secondary voltage of the regulator, and E_2 the feeder voltage. I_2 is the feeder current at an angle of φ behind E_2. The power generated in the secondary windings of the regulator is the vector product of E B and I_2. To produce this by transformer action a corresponding kilovolt-ampère load will necessarily be taken by the primary ; that is to say, a current I B will be taken by the primary of the regulator equal in magnitude to $I_2 \times E\,B/E_1$ and displaced in phase from E_1 by the same angle that I_2 is displaced from E B. In other words, if E B lags behind E_1 by the angle ψ, I_2 will lag behind I B by ψ. I_1, the total current on the supply side, will be the vector sum of I B and I_2. There are then two triangles, the electromotive force triangle E_1, E B, E_2, and the current triangle I_2, I B and I_1. But since $I_2/I\,B = E_1/E\,B$ and the angle between I_2 and I B is the same as the angle between E and E B, namely 180 deg. $- \psi$, the two triangles are similar and the two angles at the origin are the same, so that the angle of lag between I_1 and E_1 is indentically the same as that between I_2 and E_2. The effect of the magnetising current of the regulator naturally has a slight effect on the power factor, but it is almost negligible, the increase of lag even on regulators with a 10 per cent. boost being only 1 deg. to 1½ deg. Those who are interested in the theory of the induction regulator should consult Mr. H. A. Carr's paper on "The Use of Induction Regulators," read before the Institution of Electrical Engineers on January 1st, 1925.

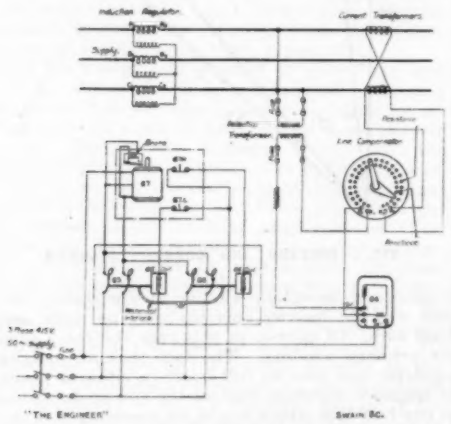


FIG. 5—CONNECTIONS FOR AUTOMATICALLY-CONTROLLED REGULATOR

Induction regulators, manufactured by the Metropolitan-Vickers Electrical Company, conform with the requirements of British Standard Specification No. 72 for transformers, and they are made in sizes up to 800 kilovolt-ampères and for a maximum pressure of 11,000 volts. Feeder regulators are usually designed for boosts of ± 5, 7½ or 10 per cent., but they may be designed for any other boost desired. The primary winding may, as we have already said, be mounted either on the stator or on the rotor, depending upon the output and the voltage, the secondary winding being of course mounted on the other part. The stator yoke consists of a rigid iron casting, and in the case of air-cooled regulators it is provided with cored holes to allow of free ventilation, whilst in the oil-cooled types it consists of a stout skeleton which allows of free oil circulation.

The stator core is composed of silicon steel laminations of high permeability and low hysteresis loss, insulated from each other by means of paper and treated after punching to remove burrs. The rotor core is also built up of laminations similar to those on the stator core. In general, the slots on the stator and rotor are open, and stiff finger plates at each end of the core keep the teeth from spreading and hold the core rigid. As the secondary windings are inserted in the supply circuit, and are subjected to the full line pressure, both the stator and rotor windings are manufactured and insulated in precisely the same manner. Each turn is insulated with impregnated cotton tape, whilst in the case of regulators for pressures above 6600 volts, each turn is insulated individually by means of mica tape. When there is more than one column of conductors in the slot, each column is insulated from the adjacent columns, with cambric or mica tape, depending on the voltage. The portion of the coil which lies in the slot is insulated with mica wrap, in a special machine, and in such a manner that the coil is a solid mass free from internal air spaces. All high-tension windings are completely formed and insulated before they are inserted in the open slots in the core.

FIG. 6—OIL-IMMERSED SELF-COOLED INDUCTION REGULATORS—METRO-VICKERS

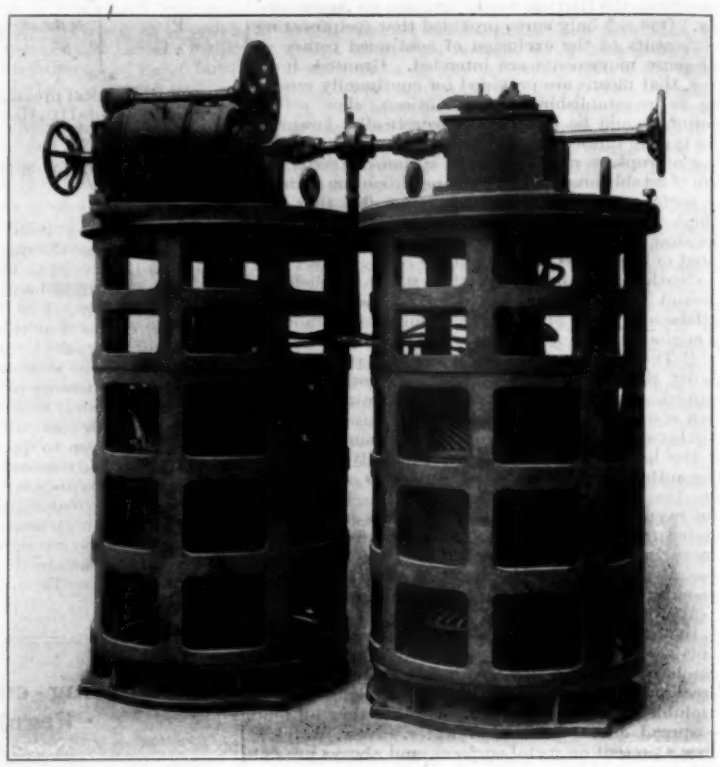


FIG. 7—DOUBLE INDUCTION REGULATOR FOR FEEDER CONTROL—METRO-VICKERS

Large induction regulators made by the Metropolitan-Vickers Electrical Company are of the oil-immersed type, and are enclosed in boiler-plate tanks, as shown in Fig. 6. In the case of oil-immersed self-cooled regulators, the effective cooling surface of the tank is increased by external radiating pipes, which are welded into the sides of the tank, whilst in oil-immersed water-cooled regulators water circulates through a cooling coil immersed in the oil. The illustration Fig. 7 shows one of the Metropolitan-Vickers Electrical Company's double induction regulators for feeder control, the regulator being removed from its case. The regulator is capable of

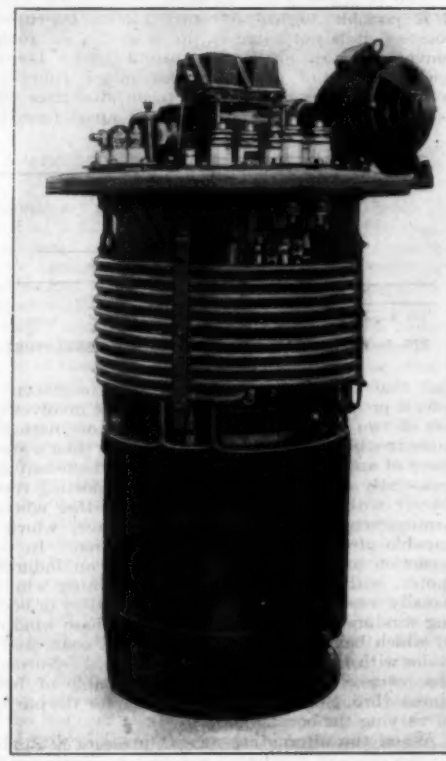


FIG. 9—OIL-IMMERSED WATER-COOLED INDUCTION REGULATOR—ENGLISH ELECTRIC

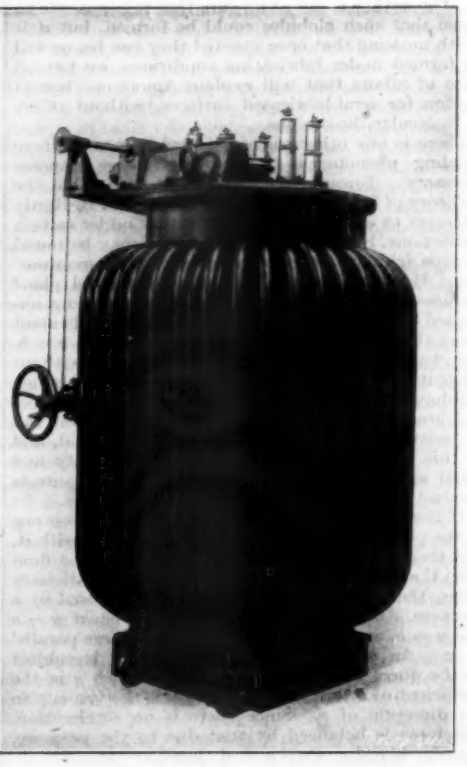


FIG. 10—15,000-VOLT OIL-IMMERSED INDUCTION REGULATOR—ENGLISH ELECTRIC

giving a boost of 7½ per cent. on a 3300-volt 50-cycle 3000-kilovolt ampère circuit. Medium-sized regulators, and particularly when they are designed for low voltage, may, if desired, be of the forced air-cooled type, the cooling air being supplied by a blower driven by an auxiliary motor or by other means. Very small regulators up to about 50 kilovolt-ampères and working at low voltages may be of the simple air-cooled type.

Regulators of this kind, built by the Metropolitan-Vickers Electrical Company, are made with standard induction motor frames, and with horizontal or vertical shafts, and they are adjusted by means of a simple hand-operated worm gear. Hand control, motor control or fully automatic control may be adopted. In the former case the regulator is mounted near the switchboard, from which the circuit in which the regulator is connected is controlled, and a hand wheel and worm gear are provided for operating the regulator. In the case of motor-operated regulators that are not designed for fully automatic operation, a small squirrel-cage motor is mounted on top of the regulator, and it is controlled from the switchboard by means of a push button or similar device. The motor drives the rotor spindle of the regulator through a spur and worm gear, single or double-reduction gears being employed according to the size of the regulator. In the case of the largest regulators a magnetic brake is fitted on the motor shaft to ensure that the movement of the regulator ceases immediately the motor is switched off. Limit switches prevent the motor turning the regulator beyond the allowable limits, and mechanical safety stops are also provided.

Fully automatic control gear is supplied principally with regulators used as feeder boosters. A complete diagram of connections for a fully automatically-controlled regulator, made by the Metropolitan Vickers Electrical Company, is shown in Fig. 8, where a voltage regulating relay is shown at 64, auxiliary contactors at 65 and 66, the motor for the induction regulator at 67, a top limit switch for the induction regulator at 67H, and a bottom limit switch for the regulator at 67L. As the feeder voltage rises or falls beyond set limits the voltage regulating relay closes contacts, which energise one or the other of the contactors, which in turn control the direction of rotation of the motor and cause it to start and operate the regulator, so as to raise or lower the feeder voltage as required. Immediately the normal voltage is restored, the voltage-regulating relay causes the motor to stop. In some cases induction time delay relays are employed to energise the motor control contactors after a time interval in order to prevent the induction regulator gear responding to momentary variations in voltage. To increase the voltage on a feeder the regulator may be placed at the supply end or at the consumer's end of the feeder, but it is more usual to place it at the supply end, for the losses and magnetising current of the regulator do not in that case have to be transmitted over the feeder. Moreover, supervision is usually easier. At no load there is no drop along the feeder, and the function of the regulator is to raise the voltage as the load comes on, so as to compensate for the line drop, and that may be done by means of a motor controlled by a push button or by a fully automatic arrangement as described.

When the induction regulator is installed at the supply end of a feeder to control the voltage at the remote end a drop compensator must be employed, and in the case of hand-controlled regulators the compensator is connected to a voltmeter, which indicates the actual voltage at the remote end of the line. In the case of automatically-controlled regulators the compensator is connected in the circuit of the voltage regulating relay, which then maintains the desired voltage at the remote end of the feeder. The Metropolitan-Vickers line drop compensator is designed to reproduce the line drop in the feeders both for phase and magnitude, and it consists of an adjustable resistance and reactance fed through current transformers and provided with tappings by means of which the compensator can be made suitable for feeders and transmission lines with varying characteristics.

In the single-phase induction regulator, which has a plain alternating field, the secondary voltage is directly reduced as the rotor is turned away from the full boost position, so that, if the movement be continued throughout a whole pole pitch, the secondary voltage will reverse in direction from its original value, thus giving the full range of regulation without any phase shift. In order to keep down the impedance of a single-phase regulator when the rotor is in the no-boost position, an additional short-circuited winding is mounted on the primary part. For use on polyphase circuits a three-phase regulator is naturally preferable to three single-phase regulators.

The English Electric Company's induction regulators for the regulation of feeder voltage are also generally oil-immersed, and may either be self-cooled or artificially cooled by the circulation of water through cooling pipes, or by the circulation of the oil itself through some form of cooler external to the regulator tank. A typical example of this company's three-phase oil-immersed water-cooled induction feeder regulator, with a capacity of 150 kilovolt-ampères, is illustrated in Fig. 9, which shows the regulator removed from its tank. The whole of the apparatus forms a self-contained unit, which is attached to the iron cover so that it can be removed from the tank without disturbing connections or any of the operating gear. This particular regulator is designed for operation on a 60-cycle, 3300-volt line, and it is capable of giving a regulation of plus or minus 190 volts per phase when carrying a current of 265 ampères. The operating mechanism is designed so that it may be under the control of a voltage relay or be controlled by means of a push-button from a distance, the majority of this company's regulators also being fitted with a hand-wheel for emergency operation. Another of this company's induction regulators is illustrated in Fig. 10, which represents a three-phase regulator designed for an exceptionally high pressure, namely, 15,000 volts, and the makers believe that it is probably the only induction regulator that has been designed for that pressure. The capacity of the regulator is 135 kilovolt-ampères, and it is of the oil-immersed self-cooled type. It is hand operated, and its function is to control the voltages on an extra high-tension system, so that power may be transmitted in either direction. At the present time the English Electric Company is building some three-phase 50-cycle, 6600-volt regulators with a capacity of 870 kilovolt-ampères, these being of the self-cooled oil-immersed type, and provided with motors, so that they can be operated on the remote control system from a switchboard. The voltage variation in this case is plus or minus 10 per cent. This company is supplying a number of these large regulators for use in connection with an inter-linking scheme in the Midlands.

Air Pollution in English Towns and Cities.

By JOHN B. C. KERSHAW, F.I.C.

THE annual report of the Committee for the Investigation of Atmospheric Pollution, covering the observations made during the year ending March 31st, 1925, has recently appeared, the publication being much earlier than usual owing to the criticisms which have been made concerning the delay in the appearance of past reports. In the following article the contents of this Eleventh Report are submitted to an analysis, on the lines of those which have appeared in previous issues of THE ENGINEER.

RESULTS OBTAINED WITH THE STANDARD GAUGE.

Section 1 deals with the figures for the deposits of impurity, as measured by the standard method and standard gauge at forty-eight different stations, this being an increase of three over the previous year. Tabular statements of the detailed results are given for the different stations, and also tables showing the highest and lowest deposits compared with the general average for the preceding five years. A general comparison shows that the rainfall was higher than the average, while the deposit of tar was lower; and that there was but little difference in the deposit of soot and solid matters. The total impurity was somewhat less than the average in most stations, although greater in London. During the last two or three years it must be admitted that but little progress has been made in clearing the atmosphere from solid impurity, and the rate of progress which was observable in the years directly after the war has not been maintained.

Nineteen public health and other authorities are now carrying on the work, and forty-eight gauges have been installed, as follows:—County of London, 6; Meteorological Office, 2; City of London, 1; London total, 9. Birmingham, 3; Blackburn, 2; Bournville, Birmingham, 1; Glasgow, 9; Huddersfield, 2; Kingston-upon-Hull, 1; Kingston upon-Thames, 1; Leeds, 4; Liverpool, 1; Marple, Cheshire, 1; Newcastle-on-Tyne, 3; Rochdale, 2; Rothamsted, 1; St. Helens, 1; Salford, 3; Southport, 2; Stoke-on-Trent, 1; and Wakefield, 1. Twenty of these gauges are of the new stoneware type. Two of the three additional gauges have been installed at Newcastle-on-Tyne; the other one is at Stoke-on-Trent, which is the new authority to undertake these observations. The Committee points out, however, that a very large area of the country is still unrepresented in these returns. It is noteworthy that Wales does not possess a single observation station and that Scotland is only represented by Glasgow.

The Midland area of the country is therefore the only one which is co-operating adequately in this work of measuring air pollution, and if one excludes London, Glasgow and Newcastle from the list, the remainder of the country is showing absolute indifference to this work. The Government Smoke Abatement Bill, which is scheduled for introduction during the present session of Parliament, may be hoped to dispel this attitude of apathy and indifference to what is really a very essential public health service.

THE LONDON RESULTS ANALYSED.

Examining the figures for London in detail, we have the following comparison of the total fall of solid matter in the two separate years 1923–24 and 1924–25, with the average for the five years 1918–1922, all the results being expressed as metric tons per 100 square kilometres:—

TABLE I.—*London's Soot and Dust Fall: Total Solids.*

Station.	Five-year average, 1918–1922.	One year, 1923–4.	One year, 1924–5.
Meteorological Office	13,424	11,743	13,097
Archbishops' Park	13,763	11,958	—
Finsbury Park	14,478	9,138	11,667
Ravenscourt Park	14,321	9,680	7,929 9,855*
Southwark Park	19,178	12,155	11,364
Wandsworth Common	8,882	8,993	10,950
Victoria Park	11,562	9,190	10,323
Golden-lane	15,311	16,673	13,009
General average for eight stations	13,865	11,192	11,653

* A new stoneware gauge.

It will be seen that when compared with the results of the year 1923–24 there has been a slight setback, for the average of the eight London stations in the year 1924-25 was 11,653, as compared with 11,192 for the year 1923–24. These figures equal respectively 298 and 286½ tons per square mile; but even the higher total compares very favourably with the total fall of solid impurity recorded in the manufacturing towns of the Midlands and the North. The improvement of London's atmosphere when compared with the average for the five years 1918–22 is also maintained, for the reduction in 1924–25 amounts to 2212 metric tons per 100 square kilometres, equivalent to 56½ tons per square mile.

THE GLASGOW RESULTS.

Glasgow is the only city besides London which operates a large number of gauges, and the figures for the nine Glasgow stations are given in similar form to those of London, below:—

TABLE II.—*Glasgow's Soot and Dust Fall: Total Solids.*

Station.	Five-year average, 1918–22.	One year, 1923–24	One year. 1924–25.
Alexandra Park	11,988	12,938	9,360
Bellahouston Park	10,904	11,744	9,765
Blythswood-square	16,399	13,253	12,937
Botanic Gardens	13,770	12,910	14,537
Queen's Park	11,079	9,402	8,209
Richmond Park	13,996	15,703	12,009
Ruchill Park	12,442	9,798	8,941
Tollcross Park	13,182	14,735	12,061
Victoria Park	11,541	12,535	12,290
General average for all the stations	12,812	12,557	11,123

Compared with the preceding year, and also with the five years' average, the 1924–25 returns from Glasgow show considerable improvement. It must be remarked, however, that the figures for the soot and dust fall in 1923–24 were exceptionally high, and that the average of the nine Glasgow stations in 1922–23 was only 9930, so that the 1924–25 total is not quite so satisfactory as it appears.

It is noteworthy that both London and Glasgow, the two cities which are taking the greatest interest in these soot and dust fall observations, show very similar average figures for the year 1924–25, and the comparative cleanliness of their atmosphere becomes apparent when one studies Table III. This table gives the soot and dust fall of all the other towns and cities carrying on these observations, and also includes the London and Glasgow figures.

TABLE III.—*The Soot and Dust Fall of English and Scotch Towns and Cities.*

Total deposit of solid matter expressed as metric tons (2204 lb. per 100 square kilometres.

Town or city.	No. of gauges.	1923–24.	1924–25.
Group I.			
Newcastle-on-Tyne	3	34,592	30,141
Rochdale	2	31,010	26,387
Wakefield	1	—	24,506
Liverpool	1	25,794	23,087
Blackburn	2	24,969	23,014
Group II.			
Kingston-upon-Hull	1	15,792	16,660
St. Helens	1	16,632	15,272
Salford	3	14,844	15,162
Group III.			
London	9	11,192	11,653
Glasgow	9	12,557	11,123
Leeds	4	13,288	11,064
Birmingham	3	11,779	11,004
Huddersfield	2	7,601	10,932
Group IV.			
Kingston-on-Thames	1	—	7,938
Bournville (Birmingham)	1	4,781	7,762
Rothamsted	1	3,903	6,969
Southport	2	4,717	4,568
Marple, Cheshire	1	—	4,085

It will be noted, in addition to London and Glasgow, that Leeds, Birmingham, Salford and Newcastle have three or more gauges installed, and a more correct estimate of the amount of air pollution is, of course, obtained in places where several gauges are employed than in towns or cities where only one is installed. Liverpool, as the writer has repeatedly pointed out in previous articles, occupies a very high place in these tables, because it possesses only one gauge, and it is placed in what is probably the dirtiest district of the city.

Newcastle-on-Tyne and Rochdale are still at the head of Group I., which contains the totals for cities having a fall of over 20,000 metric tons per 100 square

kilometres. The Newcastle result, however, is based on the amount collected in the old gauge which is situated in the City-road, in the heart of the town, and the results for the current year, ending March 31st, are certain to be very much lower, since two additional gauges of the stoneware type have now been at work for nearly twelve months, in other less dirty quarters of the city.

Liverpool is another city in which it is impossible to obtain accurate figures for air pollution, with only one gauge, and no doubt in another year or two the Liverpool health authority will follow Newcastle's example, and will install two or three additional gauges in different quarters of the city. Professor W. H. Roberts, the city analyst, in a recent speech, emphasised the fact that the Liverpool returns were about as bad as they could be, owing to the position of the gauge in one of the smokiest quarters of the city.

The second group with a soot and dust fall of between 15,000 and 20,000 metric tons, includes Kingston-upon-Hull, St. Helens and Salford. Considering that these three towns are the centres of very busy manufacturing districts, the returns may be classed as good, and are a great improvement on those found in Group I. The Kingston-upon-Hull and Salford totals are rather higher than those for the previous year; while the St. Helen's total is reduced.

London, Glasgow, Leeds, Birmingham and Huddersfield are included in Group III., with soot and dust falls of between 10,000 and 15,000 metric tons per 100 square kilometres, and this group of large cities shows what can be achieved in this particular field, when the public health authorities are keenly alive to the importance of air sanitation. It is certainly noteworthy that three of our largest cities are included in this group.

Group IV. contains the figures for the purely residential towns and country districts, with totals ranging from 4000 to 7000, and indicates the lowest limit of solid pollution which can be expected under present conditions in non-manufacturing districts.

Whether we shall attain this standard of cleanliness in our larger cities and centres of manufacturing industry within the next generation, remains to be seen, for it is probable that during the next ten or fifteen years all the small isolated power plants of the country will have been scrapped, and that electric power from the large central supply station will be used for operating all the minor industries of the country, with a considerable diminution in the amount of air pollution from smoke. The domestic smoke problem, however, will not be solved by electricity—and unless coalite or some other form of smokeless fuel is obtainable at reasonable cost and has displaced raw coal for domestic heating purposes, it is improbable that the figures for the soot and dustfall of the towns now grouped in Section IV. can be much reduced.

Highest and Lowest Results.

The report gives a table showing the highest and lowest results compared with the general average. From this table the following particulars have been abstracted:—

Table IV.

	Highest.	Lowest.
Rainfall	Blackburn	Kingston-upon-Hull
Tar	Newcastle	Headingley (Leeds)
Carbonaceous matter	Newcastle-on-Tyne	Headingley (Leeds)
Insoluble ash ..	Newcastle-on-Tyne	Marple (Cheshire)
Volatile salts ..	Wakefield	Birmingham, S.W.
Soluble ash	Wakefield	Marple (Cheshire)
Total solid deposit	Newcastle-on-Tyne	Headingley(Leeds)
Sulphates	Wakefield	Headingley (Leeds)
Chlorine	Wakefield	Birmingham, S.W.
Ammonia	Huddersfield ..	Southport and Bournville (Birmingham)

It is remarkable that Wakefield should show the highest results for soluble ash, sulphates and chlorine, whereas Birmingham, another manufacturing town, shows the lowest, and the report makes the following comment upon this feature of the 1924–25 returns:—

> With regard to the chlorine, it is interesting to observe that Birmingham, which is the station furthest removed from the sea, has least chlorine, both in the general average and for the current year. St. Helens, which is not far from the coast, shows the largest amount of chlorine in the general average; while in the current year Wakefield, almost midway between the east and west coasts, shows the most.

The Committee evidently imagines that the chlorine which is found as chloride in the rainfall is due entirely to salt spray carried by the winds inland from the coast. It overlooks the fact that in towns where the heavy chemical industry is carried on there is always a considerable amount of chlorine gas and hydrochloric acid escaping into the atmosphere. In St. Helens and Newcastle the larger portion of the chlorine found in the water collected by the soot and dust gauges is probably due to these escapes, and not to salt spray from the coast; and it is highly probable that the high Wakefield results for soluble ash, sulphates and chlorine are due to the nature of the manufacturing industries carried on in that town.

With regard to the deposits of sulphate, the report states that a rather curious relation exists between the amount of sulphate deposited from the air and the amount of total impurity; and that, roughly speaking, the greater the total weight of impurity deposited the lower the percentage of sulphate. A table has been prepared, and is given on page 28 to illustrate this point, three stations being taken with varying total impurities, namely, Golden-lane (London), Newcastle-on-Tyne, and Malvern Wells.

Table V.—*Relation of Sulphur Deposit to Total Impurity.*
Metric tons per 100 square kilometres.

1921–22. Station.	Sulphates as SO_3.		Total solids.	
	Summer.	Winter.	Summer.	Winter.
London, Golden-lane	614	836	6,935	7,023
Newcastle-on-Tyne	750	845	11,066	10,277
Malvern	354	394	1,292	1,419

The following extract taken from the report gives the Committee's comments upon these figures:—

> Looking at the winter figures for Golden-lane for the year 1921–22, we have a total deposit of 170·8 tons, a sulphur percentage of 11·9 and carbonaceous 24. At Malvern, with a deposit of 36·3 tons, the sulphur percentage was 27·8 and the carbonaceous 5. It is evident that we have here some factor calling for an explanation. It may be assumed that the origin of the sulphates at Malvern is from fires and probably from distant cities. Why, then, should the sulphate increase in concentration relative to the other constituents as the distance it travels increases? Have we here a selective deposit by which the sulphur impurities remain longer in suspension than the carbonaceous and insoluble dust? Evolution of sulphur acids from fires must be in fairly constant quantity, and cannot depend upon the smoke emission. Thus, when the sulphur content of the deposit is given as a percentage of the total, it is reasonable to expect that it will show an inverse relation to that total; for example, if we take an extreme case of no smoke being emitted, the quantity of sulphur remaining the same, it will form an extremely high percentage of the total deposit, as the products being soluble come down with the rain. On the other hand, should solid matter be emitted, such as soot and ash, this will tend to reduce the percentage of sulphur when taken on the whole deposit.
>
> In support of this is the fact that although the percentages of sulphates at Malvern are excessively high, the actual quantities are very low. For example, in the summer of 1921–22, Malvern had 27·4 per cent. of sulphates accounted for by a total sulphate deposit of 354 metric tons per 100 square kilometres. Newcastle had a percentage of 6·8, but a deposit of 750 metric tons per 100 square kilometres; and London 8·8 per cent. and 614 metric tons per 100 square kilometres.

Limits of space will not permit any further examination of the details of the report, but it may be stated that Section 2 deals with the automatic recorder for suspended impurity, and some interesting results are given for Blackburn and Stoke-on-Trent. The effect of wind in governing the concentration of impurity is also dealt with at some length in this section.

Section 3 describes observations made with the new type of dust counter in different countries. There are also observations on settlement during smoke fogs, and a new explanation is given of the causation of the "London particular" type of fog.

In Section 4 the special researches undertaken by the Committee are described.

Copies of the publication are obtainable from all branches of H.M. Stationery Office, and through any bookseller.

High Frequency Fatigue Tests.

In 1911 the late Professor Bertram Hopkinson studied the effect of rate of alternation of stress on the fatigue limit of metals by means of an electrically operated machine capable of applying alternating direct stress at speeds up to about 7000 cycles or periods per *minute*. That speed was more than three times as fast as any previously used in such tests. Comparing his results at about 7000 periods with those obtained from the same material, a mild steel, by Dr. Stanton at 2000 periods per minute, he formed the view that they showed that speed had a marked effect on the fatigue limit. He did not, however, consider his tests as conclusive, and, according to Professor C. F. Jenkin, knowledge gained regarding fatigue testing since 1911 suggests that neither Hopkinson's nor Stanton's tests can be accepted as satisfactory.

Some time ago Professor Jenkin decided to reinvestigate the subject, and, if possible, to extend Hopkinson's already high speed to a very much higher figure. The methods he employed and some of the results obtained were dealt with in a paper published last year in the "Proceedings" of the Royal Society. Professor Jenkin's work was undertaken for the Engineering Research Board of the Department of Scientific and Industrial Research. The Royal Society paper in which he described it has recently been republished by H.M. Stationery Office as Reports and Memoranda No. 982 of the Aeronautical Research Committee.

For the speeds contemplated, of the order of several thousand periods per *second*, none of the methods of fatigue testing in common use appeared to be suitable. The only possible system to follow seemed to be one in which the test piece was in the form of a vibrating spring. It was decided to maintain the vibrations electrically, and in order to reduce the power required for the purpose, to adopt the resonance method employed by Hopkinson. This method demands a very accurate tuning of the periodicity of the electrical supply with the periodicity of the test piece, and to secure the required accuracy it was decided to obtain the electrical supply by means of a thermionic valve and a tuned circuit.

The test pieces consisted of pieces of round wire, cut, straightened and heat treated. They varied in length in accordance with the periodicity at which they were to be tested. For 50 periods per second the length was 19·4in., while for a periodicity of 2000 per second it was 2·54in. No difficulty was encountered in making the apparatus required for conducting the tests on the lines indicated, so long as the periodicity did not exceed 1000 per second. The design used is shown in Fig. 1. Above the speed named difficulties began to intrude, and above 2000 periods per second the method became impossible because of the shortness of the test pieces.

In the apparatus, Fig. 1, the specimen is supported at its nodes in a manner permitting it to vibrate freely. The nodal supports consist of brass trunnions attached to the frames by bundles of fine copper wires and steadied vertically by three needles, two below and one above each trunnion. Current flows through the specimen from one trunnion to the other, the copper wire bundles providing the leads. The test piece lies between the poles of an electromagnet producing an approximately uniform field normal to it. The vibrations of the specimen are maintained with a very small expenditure of power by adjusting the frequency of the alternating current in the specimen to exact equality with the natural frequency of the test piece. The amplitude of the vibrations can be regulated by adjusting the strength of the current. The amplitude of the specimen at its mid point is measured by means of a microscope, and from it the stress in the specimen at that point is calculated by means of an equation, developed by Lord Rayleigh, governing the vibration of a beam supported at the nodes with its ends free.

The arrangement finally adopted for the oscillating circuit is shown in Fig. 2. The induction coil L was made with twenty taps, to which three twenty-point switches were connected, so that the number of coils in the anode circuit, the condenser circuit, and the power circuit could be varied independently. The reaction coil connected to the grid of the valve was provided with six taps. A small battery was connected in the grid circuit, so that its potential could be adjusted. The induction coil had an iron core made of transformer plates, the number of which was varied in the different tests. The mica condensers K were subdivided in such a way that any capacity from 2 mfd. down to 0·001 mfd. could be plugged into circuit. For fine adjustment, a 0·003 mfd. variable condenser was used. Anode current was supplied by a 600-volt 0·1-ampère dynamo, driven by a ½ horse-power direct-current motor running up to 4000 revolutions per minute. Ripples were eliminated by means of a choking coil and condenser. The high-tension current given by the valve was transformed into the low-tension current required in the test piece by a transformer consisting of two or three turns of heavy flexible cable wrapped round a choke coil wound with 2000 turns. The usual ratio of transformation was 1000 to one.

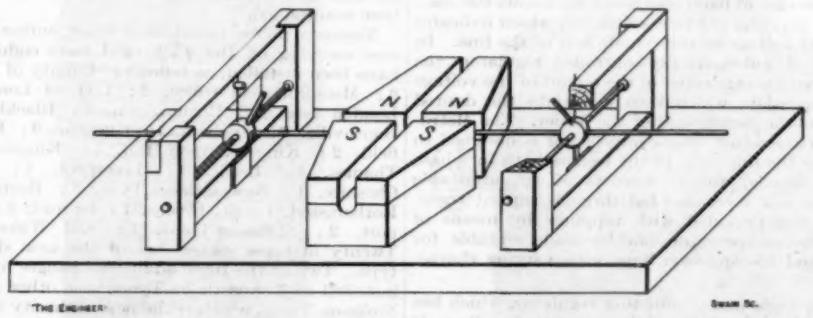


FIG. 1—APPARATUS FOR HIGH FREQUENCY FATIGUE TESTS

The frequency with which the test pieces vibrated was measured by means of a stroboscope, the disc of which had twenty slots, and ran at speeds up to 4000 revolutions per minute. Vision was directed through the slots on to the end of the test piece.

Three materials were tested, namely, copper (99.97 pure), Armco iron, and a mild steel. The specimens were in the form of wire about 0.104in. in diameter. The tests were continued without interruption until fracture occurred or until at least ten million cycles had been completed without fracture. The first sign

of failure observed was the reduction of the amplitude resulting from an increase in the natural period of vibration of the test piece. When the apparatus was retuned it would quickly go out of tune again, and when the motion was stopped the specimen would be found to be cracked. In this respect the apparatus behaved in striking contrast with ordinary fatigue testing machines with which it is very difficult to

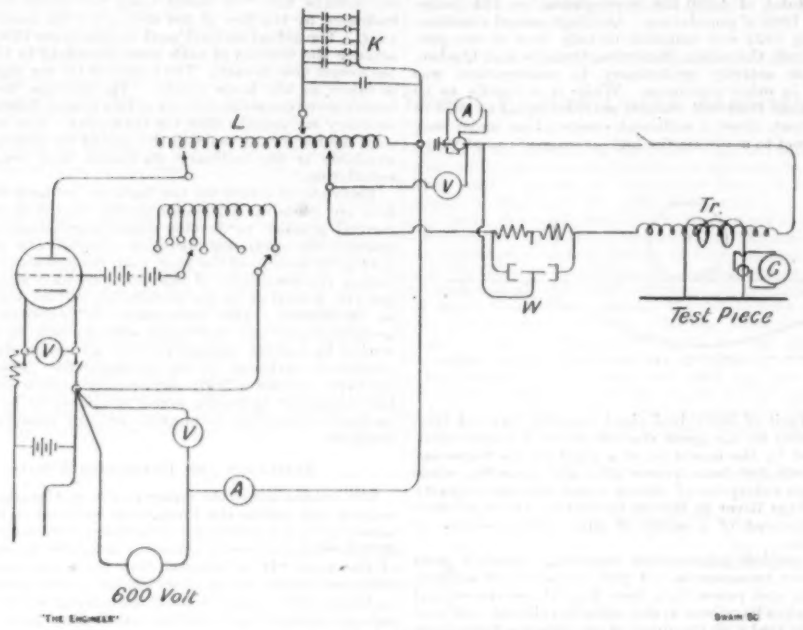


FIG. 2—ARRANGEMENT OF OSCILLATING CIRCUIT

catch the specimen with a crack in it before complete failure occurs.

Professor Jenkin's results may be summarised in tabular form, as follows :—

	Periods per sec.	Periodic time, secs.	Fatigue stress, tons/sq. in.	Millions of periods without fracture.
Copper	50·3	0·02	4·88	—
	504·7	0·002	5·01	15·3
	972·4	0·001	5·33	12·6
	1987·5	0·0005	5·53	10·8
Armco iron	50	0·02	15·75	10·2
	501·7	0·002	16·65	12·3
	*980	0·001	16·8	12·5
	1003·5	0·001	16·98	15·62
Mild steel ..	49·5	0·02	16·3	—
	498	0·002	16·85	12·5
	978	0·001	17·35	12·2

* Specimen subjected to cold air blast during test.

The results show that the mechanism of fatigue requires time to develop. In all three cases the fatigue stress rises with the speed. At high speeds loads which are sufficient to cause fracture at lower speeds are not given time to produce the effect,

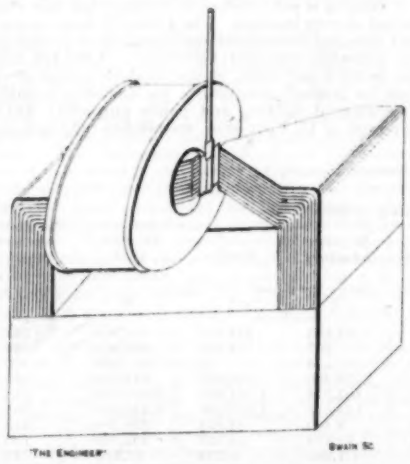


FIG. 3—DEVICE FOR IMPARTING TORSIONAL VIBRATIONS

whatever it may be, which causes fracture. Any theory of fatigue must take account of this time effect, but from the practical point of view the gain in resistance to fatigue with increase in the speed is insignificant. So far as ordinary fatigue tests are concerned, the effect of variation in the speed may also be dismissed as insignificant.

It was thought that the rise in the fatigue limit with speed might be a temperature effect. Thermo-couples were applied to the specimens to measure the temperature rise suffered by them. The copper test pieces, it was found, never rose more than 8 deg. Cent. above the atmospheric temperature. The Armco iron specimen was found to be 40 deg. Cent. hotter at 1000 periods per second than at 50 periods. It was subjected at 980 periods to a blast of cold air, which reduced the temperature rise to 10 deg. Cent. The mild steel specimen suffered a rise of 50 deg. Cent. at 1000 periods. The material was tested at 50 periods when subjected to a hot air blast of an intensity sufficient to bring its temperature up to that registered by the 1000-period specimen. The results for both the Armco iron and the mild steel showed that the rise in the fatigue stress with increase of speed could be only very slightly produced by the increase of temperature at the higher speeds.

It was decided to carry out tests at still higher frequencies. In the original apparatus the amplitude of vibration at the centre of the specimen when the frequency was 2000 per second was only 0.08 mm., and was insufficient to cause the fracture of the Armco iron and mild steel specimens. To reach the higher speeds, new apparatus—Fig. 3—was designed, with the object of subjecting the specimens to torsional instead of transverse vibrations. The specimen in the form of a wire or tube was fixed at the upper end and at the lower end was provided with an armature composed of "stalloy" sheets, brazed to a sleeve of non-magnetic steel. The armature was disposed between the poles of an electromagnet, made of "permalloy" stampings, the position of the armature being such that when the magnet was excited the specimen was twisted. Alternating current was supplied to the magnet from an oscillating circuit tuned to the natural period of torsional oscillation of the specimen. The twist of the specimen was measured by means of a small mirror attached to it, just above the armature.

Tests on copper tube, 0.104in. outside diameter and 0.078in. bore, were carried out at 3000 and 4000 periods per second. At 3000 periods the specimen was unbroken after 25 million cycles and at 4000 periods 60 million cycles were sustained without fracture. The stress applied was about five-eighths of the fatigue stress at 2000 periods, as determined by the first series of experiments. Higher stresses could not be applied, for the power of the apparatus was, apparently, limited by the magnetic saturation of the material composing the armature. All attempts to obtain larger twists were fruitless, and the experiments had to be abandoned.

The Fracturing of Fish-plates.

By N. GARRETT SMITH.

ALTHOUGH a few references to the fact can be found, it does not appear to be generally recognised that the majority of fractures of fish-plates begin at the top edge. The author has recently had an opportunity of examining a very large number of broken fish-plates from one of the railways in India, in almost all of which the fractures had started from the top edge, and in the following note proposes to discuss the reasons for this type of failure and its effect upon the general design of fish-plates.

In the plates examined by the author failure was only partial, the crack starting from the middle point of the top edge and finishing near the neutral axis, clearly indicating negative bending stresses.[1] With tensile or shear stresses as the cause of failure, fracture would generally have been complete. The defective plates were found under all conditions, on straights and on curves, with cast iron or wooden sleepers and even where there was little or no creep. They were 26in. long with four bolt holes spaced at 6in. pitch. *(The British standard fish-plate for four holes is only 18in. long.) Some had only a very small flange reinforcing the bottom edge, others a big flange, and a few had in addition a slight vertical protruding foot. They were supplied from various different sources, being both of English and of Indian manufacture.

THE STRESSES IN A FISH-PLATE.

The design of fish-plates has generally been based on the assumption that the maximum bending stresses would be imposed when the load was vertically over the joint. The bottom edge would then be in tension, and it has therefore, in some designs, been strengthened with a heavy horizontal flange, and occasionally even with an additional vertical flange on the end of the horizontal one. In fact, many different kinds of designs have been introduced and tried with the object of stiffening the joint. The following considerations will show the fallacy of this idea.

Experience has shown that failure, whether in plain or angle plates, nearly always starts from the top edge, which must therefore have been in tension. How this may occur will be readily realised from a study of track depression curves. It will be found that the sleepers, the ballast and the road bed below are not rigid supports, but are elastic and capable of considerable depression. The depression of a rail between sleepers is comparatively slight and almost negligible; that is, the maximum bending moment in a rail is practically the same whether the load is over or between sleepers.

From the track depression curves the relative bending moments can easily be estimated. In rails they would be inversely proportional to the radius of curvature or directly proportional to the rate of change of direction $\frac{(d^2 y)}{(d x^2)}$. In fish-plates of uniform length the bending moments may be considered as being inversely proportional to the mean radius of curvature over a length equal to the length of the fish-plate. Examination of some of the track depression curves obtained in America[2] will show that the spacing of the wheels is often of greater importance than the actual axle load. For instance, between two wheels approximately 5ft. apart, the curves may be comparatively flat with low bending moments in the rail, but with wheels about 9ft. apart the curvature producing a negative bending moment over a length equal to the length of the fish-plates may be greater than the reverse curvature over the same length immediately under one wheel. Exceptionally severe negative bending moments may be obtained between the front wheel and the driving wheel of a locomotive or between the bogies of two heavily loaded wagons. In fact with wagons designed to carry very heavy loads bogie wheels, which, by flattening the curve under the load, will decrease the positive bending moment are used. Their effect, however, on the reverse curvature between the bogies is slight, and experience has shown that the maximum negative bending moment is generally greater than the positive.

LENGTH OF FISH-PLATES.

The general tendency in modern design is to shorten fish-plates. On some of the older lines in India six-hole plates are used, whereas nowadays only four-hole plates are supplied. Captain Walker,[3] of the Federated Malay States Railways, has stated that most of the trouble with rail joints can be traced directly or indirectly to the use of long six-hole angle plates, whereas four-hole flat plates, among other advantages, have exhibited less tendency to bind, give better alignment, easier maintenance, and very much smoother running. A further step in shortening the length will be found in the Joyce pattern fish-plate, which is being employed on some lines. Its effective length is the thick centre portion of 7in., which alone is in contact with the fishing planes; the wings lengthen the plate to 18in. and enable one extra bolt on each side to be fitted, but are not in contact with the rail and do not affect the stiffness of the joint in any way. This follows from the results of experiments by Mr. Lloyd Jones,[4] Chief Engineer of the Nizam's Guaranteed State Railway, showing that the stiffness of a joint is independent of the number and of the tightness of the bolts.

The increase in the bending moment with longer plates may be readily understood by studying the attached diagram which represents the depression of a rail between two wheels giving a negative bending moment in the middle. With joints at any point on the curve, the combined moment of inertia of the rail and fish-plate would be greater and therefore the curve would be slightly flattened. The longer and stiffer the fish-plate, the more the natural flexibility of the rail will be destroyed and the bigger will be the stresses to be borne by the fish-plate. This effect is

[1] The terms "positive" and "negative" in connection with bending moments are used where tension is produced in the bottom and top flanges respectively.

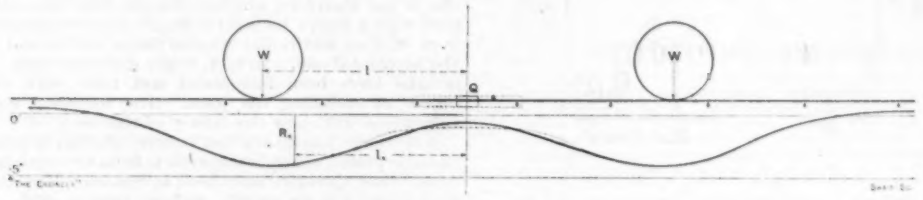
[2] "Progress Report of the Special Committee on Stresses in Railroad Track," published in *Bulletin* of the American Railway Engineering Association, Vol. 19, No. 205, March, 1918.

[3] *Journal* of the Permanent Way Institution, Vol. 41, part 1, page 260, April, 1923.

closely analogous to that of a belt spliced with pieces of glass passing over a pulley. Long pieces of glass would break, while, on the other hand, the shorter and more springy the glass the smoother the running. Mathematically the problem is analogous to weights (w) resting on a flexible steel ruler supported throughout its length by a thick pad of rubber, the resulting reaction (R) at any point being proportional to the depression. The bending moment (B M) at any point (P) is obtained by the usual equation—

$$\text{B M at P} = \Sigma_{x=0}^{x=\infty}(R_x \times l_x) - \Sigma\,(W \times l)$$
$$= \Sigma\,R \times lcg - \Sigma\,(W \times l)$$

where lcg is the distance from p of the centre of gravity of the area of depression on one side of p. Where the curve is parallel to the zero line, as in the diagram at Q, the sum of the reactions on one side



(Σ R) must equal (Σ W) and for a given load the following equation is obtained :—

$$\text{B M at Q} = (W \times lcg) - (W \times l)$$
$$= W\,(lcg - l).$$

That is to say, the bending moment is proportional to the distance of the application of the load from the centre of gravity of the area of depression. With a longer fish-plate at Q the curve will be depressed under Q and raised equivalently between W and Q, the distance from Q of the centre of gravity of the area will be reduced and therefore the negative bending moment will be increased. In the same manner it can be proved that the maximum positive bending moment is increased immediately under the load. If it be desired, therefore, to stiffen the joint it should not be done by lengthening the fish-plates.

For lateral bending stresses on curves the equation is simpler :—

$$\text{B M} = \frac{\text{E I}}{\text{Radius of curvature}}$$

With longer plates the mean moment of inertia (I) over a given distance, say 3ft., is increased and therefore the bending moment is greater, or, for a given bending moment the curve will be flattened over a length equal to the length of the fish-plate, so that the shorter the plate the smoother the running.

Fish-plates, therefore, should be made as short as practicable. As it has been proved[4] that two bolts in a pair of plates are sufficient to ensure rigidity of the joint there should be little necessity for a greater length than 7in. to 8in. It has been argued that more than one bolt on each side is required to resist creep. Practical experience alone can settle that point, but when both creep and contraction occur the forces coming into play may be enormous, and as the same extension is required to shear one bolt as is required to shear two or more, there is probably little advantage in a larger number.

With shorter plates the tensile and shear stresses would not be increased. The intensity of the pressure between rail and fish-plates would be greater, but could be counteracted by the use of harder steel, which might be employed with greater safety. It is the bending stresses which cause fish-plates to fail, and they would be reduced.

It is not within the province of this article to consider the relative advantages of supported against suspended joints, but it may be said that the former would give smoother running and reduce the intensity of the pressure between the rail and the fish-plate when the joint is immediately under the load, especially if some form of bearing plate were used.

[4] "Proceedings" of the Institution of Civil Engineers, Vol. 182, 1910.

Water Power Resources of Canada.

The Dominion Water Power and Reclamation Service of the Canadian Department of the Interior has recently completed an analysis of the water power resources of the Dominion as from January 1st last. In this review only the salient features of the situation are touched upon.

The ever-growing application of electricity to industry, the increasing public demand for better street, domestic, and commercial lighting, and the widespread use of electricity for domestic and commercial cooking, refrigerating, and the numerous other processes made possible by reasonably priced electrical appliances, have all united to create a demand for power which is being met by an unprecedently rapid development of Canada's water power resources. The fortunate occurrence of about 60 per cent. of Canada's total water power in the highly industrial but non-coal-producing provinces of Ontario and Quebec, the close proximity of water powers to the mineral and pulp wood areas throughout the entire country, and the fact that nearly all of the centres of population have water power within easy transmission distance, are circumstances which, while, of course, altogether fortuitous, combine to provide a market for power in which the supply barely keeps pace with the demand. Indeed, this is one of the outstanding points of interest in present-day developments. Where a few years ago blocks of 10,000 to 20,000 horse-power would come on the market after an extended period of construction, now plants of 100,000 horse-power or more are brought into operation within the year.

The year 1925 witnessed the unprecedented increase in Canada's hydraulic installation of 718,984 horse-power, bringing the total installation for all purposes to the imposing total of 4,290,428 horse-power, or 465 horse-power per 1000 of population. Although actual construction during 1925 was confined to only four of the provinces, British Columbia, Manitoba, Ontario, and Quebec, considerable activity preliminary to construction was evidenced in other provinces. While it is hardly to be expected that 1926 will witness activity equal to that of the past year, there is sufficient construction under way or in prospect to maintain the high average of recent years. That the limit of individual plant capacity has not been reached, even by the great stations recently constructed, is indicated by the inception of a plant on the Saguenay River of 800,000 horse-power ultimate capacity, while plans for an enterprise of almost equal ultimate capacity on the Bridge River in British Columbia, which involves the development of a series of sites, are in course of preparation.

While complete information regarding Canada's great water power resources is not yet available, all existing stream flow and power data from federal, provincial and private sources have been systematically collated, analysed and co-ordinated with the object of presenting a dependable estimate of available power based on uniform methods of computation and arrangement.

Basis of Computation.

The figures for available water power given in Table I. are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration is definitely established or at least well authenticated. Many rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the relatively unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient, on which economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record. In brief, the figures given are based on definite rapids, falls and power sites, and may be said to represent the minimum water power possibilities of the Dominion.

Table I.—*Available and Developed Water Power in Canada, January 1st, 1926.*

Province.	Available 24-hour power at 80 per cent. efficiency.		Turbine installation, H.P.
	At ordinary min. flow, H.P.	At ordinary 6 m'ths' flow, H.P.	
1	2	3	4
British Columbia	1,931,142	5,103,460	414,702
Alberta	475,281	1,137,595	34,107
Saskatchewan	513,481	1,087,756	35
Manitoba	3,270,491	5,769,444	183,925
Ontario	4,950,300	6,808,190	1,784,842
Quebec	6,915,244	11,640,052	1,747,386
New Brunswick	50,406	120,807	44,631
Nova Scotia	20,751	128,264	65,327
Prince Edward Island	3,000	5,270	2,274
Yukon and North-West Territories	125,220	275,250	13,199
Canada	18,255,316	32,075,998	4,290,428

The power estimates have been calculated on the basis of twenty-four-hour power at 80 per cent. efficiency for conditions of "ordinary minimum flow" and "ordinary six months flow." The "ordinary minimum flow" is based on the averages of the flows for the two lowest periods of seven consecutive days in each year over the period for which records are available. The "ordinary six months flow" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method used to determine this flow is to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the ordinary six months flow for that year. The average of such figures for all years in the period for which data are available is the ordinary six-month flow used in the calculation.

Estimate of power on the basis of ordinary six-month flow are made upon the assumption that it is good commercial practice to develop wheel installations up to an amount, the continued operation of which can be assured during six months of the year, with the deficiency in power during the remainder of the year provided from storage not yet created or by the installation of fuel power plants as auxiliaries. The correctness or otherwise of this assumption for any particular site can only be definitely settled by careful consideration of all circumstances and conditions pertinent to its development. The method, however, enables a fairly satisfactory overall estimate of the maximum hydraulic power available to be made as distinctive from the estimated ordinary minimum power available.

Available and Developed Totals.

The known available water power in Canada from all sources and within the limitations outlined is 18,255,000 horse-power for conditions of ordinary minimum flow and 32,076,000 horse-power ordinarily available for six months of the year. It is believed that these are conservative estimates, since an analysis of the water power plants scattered from coast to coast concerning which complete data are available as to turbine installation and satisfactory information as to stream flow gives an average machine installation 30 per cent. greater than the ordinary six-month flow power. Applying this, the figures quoted above, therefore, indicate that the present recorded water power resources of the Dominion will permit of a turbine installation of 41,700,000 horse-power. The total installation to date in water wheels and turbines throughout the Dominion is 4,290,428 horse-power. In other words, the present turbine installation represents only 10½ per cent. of the recorded water power resources.

Current Progress.

During 1925 the water power installation in Canada increased nearly twice as much as during any previous year and construction work on new developments is still proceeding at a rapid rate, but the power market has not yet shown any signs of saturation and steady progress in the installation of new water power plants can be looked for. The new installation in Quebec was 438,300 horse-power, of which 360,000 horse-power was contained in a single station on the Saguenay River. In Ontario practically 200,000 horse-power came into operation, of which nearly three-quarters was due to the efforts of the Hydro-Electric Power Commission, leaving a substantial remainder to the credit of private enterprise. In Manitoba no new stations were established, but an existing plant was enlarged by 22,000 horse-power. In British Columbia water power activities were marked and nearly 90,000 horse-power was installed.

Utilisation of Developed Water Power.

A study of the uses to which the water power installation of Canada is put emphasises the growing importance of central electric stations. The 4,290,428 horse-power at present installed throughout the Dominion is apportioned to the following uses (see Table II.) :—3,466,422 horse-power, or 80.8 per cent., of the total in central electric stations for general distribution, for domestic, municipal and commercial lighting and power purposes; 481,971 horse-power, or 11.2 per cent., installed in pulp and paper mills. In addition, pulp and paper mills purchase about 275,000 horse-power from central electric stations, making a total of nearly 757,000 horse-power used in the manufacture of pulp and paper; 342,035 horse-power, or 8 per

Table II.—*Developed Water Power in Canada, January 1st, 1926.*

Province.	Turbine installation in horse-power.				Population, June 1st, 1924.	Total installation per 1000 population.
	In central electric stations.	In pulp and paper mills.	In other industries.	Total.		
1	2	3	4	5	6	7
British Columbia	298,179	54,640	61,883	414,702	553,000	734
Alberta	33,520	—	587	34,107	637,000	54
Saskatchewan	—	—	35	35	815,000	·04
Manitoba	167,525	—	16,400	183,925	647,000	284
Ontario	1,502,520	174,548	107,774	1,784,842	3,062,000	578
Quebec	1,399,607	223,144	124,635	1,747,386	2,480,000	703
New Brunswick	23,225	13,003	8,403	44,631	399,400	112
Nova Scotia	31,567	16,636	17,124	65,327	533,000	123
Prince Edward Island	279	—	1,995	2,274	87,700	26
Yukon and North-West Territory	10,000	—	3,199	13,199	12,040	1,096
Canada	3,466,422	481,971	342,035	4,290,428	9,226,740	464

Column 2 includes only hydro-electric stations which develop power for sale. Column 3 includes only water power actually developed by pulp and paper companies. In addition to this total pulp and paper companies purchase from the hydro power central stations totalled in Column 2, horse-power estimated at about 275,000 horse-power, including a total of about 757,000 horse-power actually used in the manufacture of pulp and paper. Column 4 includes only water power actually developed in connection with industries other than the central station and pulp and paper industries. These industries also purchase blocks of power from the central stations totalled in Column 2. Column 5 totals all turbines and water wheels installed in Canada. Column 6 population at June 1st, 1924, as estimated by the Dominion Bureau of Statistics. Column 7 averages the developed water power per 1000 population.

cent., installed in industries other than central electric stations and pulp and paper mills.

WATER POWER IN THE CENTRAL ELECTRIC STATION INDUSTRY.

As indicated by the foregoing classification, the development of electricity for public distribution constitutes the leading use to which water power development is put, and there is every indication that the proportion used for this purpose will continue to increase. In the year 1900, when electricity was just beginning to come into common use, some 32 per cent. of Canada's hydraulic installation was in central electric stations. Ten years later the percentage had almost doubled—61 per cent.—while by 1920 over 71 per cent. was devoted to this purpose, growing, as shown, to 80.8 per cent. in the next four-year period. A number of factors contribute to this continued growth, notably the extensive economic radius of modern electrical transmission combined with the fortunate location of water powers in relation to centres of population and industry without adequate local fuel supplies. The special adaptation of hydraulic power to central electrical station operations is emphasised by the fact that the last completed central electric station census, that for the year 1924, shows that 95 per cent. of the total main plant equipment is in hydraulic generating stations and that this equipment produces 98.4 per cent. of the total electrical output.

At the present time there are 297 hydro-electric central stations in Canada with a total installation of 3,466,422 horse-power. Of these totals, 209 stations with an installation of 513 turbines of a combined capacity of 2,230,848 horse-power are owned by commercial organisations, while municipal or other public organisations operate 88 stations, which contain 213 turbines aggregating 1,235,574 horse-power (Table III). The average installation of the commercial stations is 10,674 horse-power and the power from a hydraulic installation of about three-quarters of a million horse-power.

CAPITAL INVESTED IN WATER POWER.

The investment represented by our present hydraulic installation of 4,290,428 horse-power has been made the subject of intensive study based largely on the figures of the annual census of hydro-electric central stations. Due allowance being made for all the varying factors entering into the development and use of hydraulic power warrants the statement that a conservative estimate of the capital investment in Canadian water powers amounts to 815,723,890 dollars.

TABLE III.—*Developed Water Power in Canada Utilised in the Central Electric Station Industry, January 1st*, 1926.

Province.	Commercial stations.					Municipal stations.				
	No. of stations.	No. of turbines.	Total turbine installation.	Average H.P. per station.	Average H.P. per turbine.	No. of stations.	No. of turbines.	Total turbine installation.	Average H.P. per station.	Average H.P. per turbine.
1	2	3	4	5	6	7	8	9	10	11
			H.P.					H.P.		
British Columbia	20	46	288,084	14,404	6,263	8	11	10,095	1,262	918
Alberta	4	14	32,560	8,140	2,326	1	2	960	960	480
Saskatchewan	—	—	—	—	—	—	—	—	—	—
Manitoba	3	9	78,400	26,133	8,711	2	15	89,125	44,562	5,942
Ontario	74	203	424,479	5,736	2,091	45	132	1,078,041	23,956	8,167
Quebec	86	225	1,380,632	16,054	6,136	16	26	18,975	1,186	730
New Brunswick	5	13	11,315	2,263	870	3	6	11,910	3,970	1,985
Nova Scotia	9	12	5,099	567	425	13	21	26,468	2,036	1,260
Prince Edward Island	7	8	279	40	35	—	—	—	—	—
Yukon and North-West Territory	1	2	10,000	10,000	5,000	—	—	—	—	—
Canada	209	532	2,230,848	10,674	4,193	88	213	1,235,574	14,041	5,801

Commercial stations include all privately owned. Municipal stations include all publicly owned. The statistics in this table are based upon a census of the industry made by the Dominion Bureau of Statistics in co-operation with the Dominion Water Power Branch.

Diesel Engine Users' Association.

AT the April meeting of the Diesel Engine Users' Association, which was held on Friday, the 9th inst., Mr. W. A. Tookey read a paper on "Industrial Tests of Internal-Combustion Engines." In contradistinction to manufacturers' tests, the tests referred to in Mr. Tookey's paper are those made at the makers' works under the supervision of an engineer acting on behalf of the purchaser. The agreed definition of the British Engineering Standard Association as regards the rated output of an engine is cited, after which the author outlines the programme of tests which it is usual to carry out. He lays stress on the importance of noting and approving the testing apparatus provided by the makers, and the desirability of making the acquaintance of the test bed staff by observing a preliminary performance of the engine to be tested the day before the actual trial. Such a procedure, he notes, enables the testing engineer to get used to the atmosphere of the test bed, which is a helpful factor in the carrying out the subsequent trials. In the author's opinion, the full or rated load trial and the overload trial are of most importance, and upon occasions when it is desirable to shorten the duration of the test to one day, it is preferable to run combined trials according to the following plan. During the first hour the engine is started from cold and run at about full load to allow it to warm up and permit the taking of preliminary readings and making the final adjustments to the testing apparatus. The engine is then run at its full rated output, and speed for the second, third and fourth hours, and under overload conditions for the fifth hour. For the sixth hour the load is again reduced to the full rated load, which trial is followed by the observation of the generator temperatures and the governor trials. After these trials full load is again put on, and is subsequently adjusted to three-quarters, and later half load, for runs of, say, twenty to thirty minutes. The quarter load and no load performance of the engine, along with the fuel consumption figure, are also noted.

After the trial the engine should be opened out for inspection. Starting trials may be usually noted during the preliminary inspection. It is important, Mr. Tookey points out, to measure the pressure and humidity of the atmosphere at the time of the trial, and in the case of engines designed to work at high altitudes to lower the air and gas pressure to coincide with the barometric pressure at the altitude at which the engines will subsequently be called upon to work.

Industrial workshops, the author says, are much better equipped in respect of testing apparatus than was the case twenty years ago. After describing the various forms of brakes and dynamometers, the author passes on to combined trials of electric generators, pumps, &c. With regard to the determination of indicated horse-power, Mr. Tookey holds that indicator diagrams if properly taken can be relied upon to enable the efficiency of any internal-combustion engine to be deduced with sufficient accuracy for industrial purposes. He is further of the opinion that the volume ratio of an engine should be determined in making engine trials. It is realised, he says, that the thermal efficiency varies with the volume ratio of an engine, but if mixture strengths were always to be compared on the basis of the total cylinder volume instead of on the more common basis of the piston displacement volume, the practical effect of the volume ratio on engine performance would be better understood industrially. The volume ratio is often looked upon, the author points out, as a theoretical quantity, but it can quite well be practically determined from the indicator cards. In the section dealing with consumption trials, Mr. Tookey gives some interesting comparative values of theoretical gas and air mixtures, and the heats of combustion for various gases. Some examples of calculated and observed calorific values of power gases are also given. Passing on to governor, ignition and mixture control, Mr. Tookey makes the suggestion that every engine should be provided with a rating plate upon which the rated output at normal speed and also the maximum and minimum speeds should be marked.

The remainder of the paper is devoted to an exposition of the author's method of expressing the thermal efficiency of an engine in the fundamental units of pressure produced per heat unit consumed, or the Tookey factor, so named at the suggestion of the late Captain H. Riall Sankey, during a discussion of the paper on "Commercial Tests of Internal-combustion Engines," at the Institution of Mechanical Engineers meeting of January, 1914. The basis of mixture strength $Q\,t$, used by the author, is the number of B.Th.U. contained in a specific cubic foot of cylinder volume plus clearance volume. The basis of pressure $P\,m$ is the positive loop of the indicator diagrams in pounds per square inch. The Tookey factor $T\,m = P\,m \div Q\,t$ for indicated horse-power; also $T\,m = 5{\cdot}4 \times E\,m \times r/r - 1$, where $E\,m$ = the thermal efficiency expressed in a decimal fraction per indicated horse-power. So that for test results in which the thermal efficiency and the mean pressure are given, the value of $Q\,t$ or mixture strength can be readily computed. To facilitate the calculation of $r/r - 1$, a table of compression pressures and volume ratio values is given. In a chart on which thermal efficiencies and $r/r - 1$ values are plotted, the variation in thermal efficiency over a wide range of old and new engines, and running with gaseous and liquid fuels, under industrial and research conditions, is shown. An analysis of these test results also indicates that without exception the higher efficiencies for a given value of $r/r - 1$ are obtained with the weakest strengths of mixture used. Further charts are given investigating on the basis of mixture strength the relation between the heat converted into work and that passing to the jacket water and the exhaust. The effect of piston speed and volume ratio on thermal efficiency, also of throttle and ignition control and varying compression ratios, are also investigated. The various tests co-ordinated by this method certainly show a close correspondence of the Tookey factors for engines of such variable types as single-cylinder petrol and gas engines to large marine oil engines. In the discussion which followed the reading of the paper, Mr. Tookey was asked to add the results of the recent Marine Oil Engine Trials Committee to his charts, and the question was raised as to whether this method of analysis was equally as applicable to the Diesel type of engine, in which a stratified combustion took place after fuel was injected into an excess of heated air, as it was perhaps to engines in which a definite mixture of air and fuel was compressed and ignited.

WATER POWER IN THE PULP AND PAPER INDUSTRY.

A recent development that is doing much to enhance the importance of the Canadian pulp and paper industry is the growing movement of American mills towards Canada, owing to the diminishment of the United States' pulp wood limits, and the fact that their water powers have, with the growth of population, attained more value for central station purposes than for pulp and paper manufacturing. The fortunate occurrence of tremendous supplies of pulp wood in close proximity to water powers, readily developable and of such size as to furnish the large quantities of power demanded by this industry, have placed Canada in the favourable position she occupies in that industry. Owing to large power demand, approximately 100 horse-power per ton of daily output of newsprint, and the prohibitive cost of transporting a bulky product such as pulp wood any great distance, this proximity of wood and power is absolutely essential to successful operation.

A recent development of interest affecting the power consumption of this industry is the rapid adoption of electric steam boilers as a means of transforming any surplus of available electric energy into steam for pulp cooking, drying, heating, &c. Ordinarily steam cannot be produced by electricity in direct competition with coal, but where surplus power can be contracted for at a specially low rate or where large consumers buying firm power have periodically an available surplus in excess of actual power requirements, such surplus power can be advantageously used in raising steam. Similarly, mills maintaining their own hydro-electric equipment are able to make full use of the water at their disposal by utilising for raising steam any excess of supply over actual power requirements.

There are 116 pulp and paper mills in Canada operating water power developments to furnish their own motive power. These mills have a combined installation of 481,971 horse-power. Numbers of these mills purchase additional power from central station organisations, while still other mills purchase all their power. Up-to-date figures of this purchased power are not at present available, but a conservative estimate places the amount at about 275,000 horse-power, so that the industry draws average capacity of their turbines 4193 horse-power as compared with 14,041 horse-power and 5801 horse-power respectively for the municipal stations. Although, as shown by Table III., Ontario has the largest central station installation among the provinces, the commercial group in Quebec forms the largest group, with 1,380,632 horse-power, Ontario's municipal stations being next in order with 1,078,041 horse-power.

Individual turbines vary in size from the 10 horse-power turbine used for hamlet lighting to the 55,000 horse-power units of the great Chippawa-Queenston station, while contracts for units of 80,000 horse-power for installation in the Saguenay River plant of the Aluminium Corporation of Canada have recently been let.

THE ITALIAN AIRSHIP NORGE.

DURING last week-end a good voyage to England was made by the Italian semi-rigid airship Norge, which will be used by Captain R. Amundsen in the Amundsen-Ellsworth expedition to the northern polar regions. She left Rome at 9.25 on the morning of Saturday, the 10th inst., and in a non-stop run arrived safely over Pulham Aerodrome at 3.20 on Sunday afternoon. A slight difficulty was experienced in the landing, but by 6.30 in the evening she was safely housed in one of the hangars. In all, about 1400 miles were covered in nearly thirty hours, giving an average speed of about 47 miles per hour; nevertheless, flying at close upon 1000ft. high, speeds of 70 miles per hour were made with the wind. The Norge was commanded by Colonel I. N. G. Nobile, her designer, but Major F. G. Scott was also on board, representing the British Air Ministry. When she landed there was about eight hours' supply of fuel in the tanks, and each of the three 250 brake horse-power Maybach engines had been rested in turn during the flight. Major Scott expressed his satisfaction with the ship and considered her well suited for the particular expedition she is about to undertake. The Norge left Pulham at 11.45 on Tuesday evening, the 13th inst., for Oslo, which she reached about twelve hours later. Early on Thursday morning she again left Oslo for Leningrad and Spitzbergen.

The airship has a length of about 300ft., with a capacity of 660,000 cubic feet, and a total lift of 12 tons; 7 tons of fuel can be carried, which will give her a cruising speed of 50 miles per hour and a range of 3000 miles in still air, a capacity which should suffice for her polar flight of 600 miles from Spitzbergen to the Pole and 1200 miles from the Pole to Alaska.

In the past most expeditions to the polar regions have had to undergo long periods of complete isolation from the outside world, since it has not been possible to carry the means of communicating with civilisation. In the present instance, however, arrangements have been made whereby the Marconi Company has equipped the airship with special transmitting and receiving apparatus, which will enable the commander to keep in touch with either ship or land stations up to very considerable distances. The airship will, in fact, be in a position to maintain communication with the outside world throughout its entire voyage through Arctic solitudes. The range of the transmitter and receiver will probably be, in regions where interference is not great, anything up to 2000 miles. On the first stage of the airship's journey to the Pole, from Rome to Pulham, Norfolk, regular two-way communication with the Air Ministry, London, was established when the Norge was over the south coast of France, and was maintained throughout the remainder of the voyage. Reception appeared to be only limited by the interference of local stations, but a good deal of interference can be eliminated by receiving on the D.F. loops. In the Arctic, where interference will be negligible, no difficulty at all should be experienced.

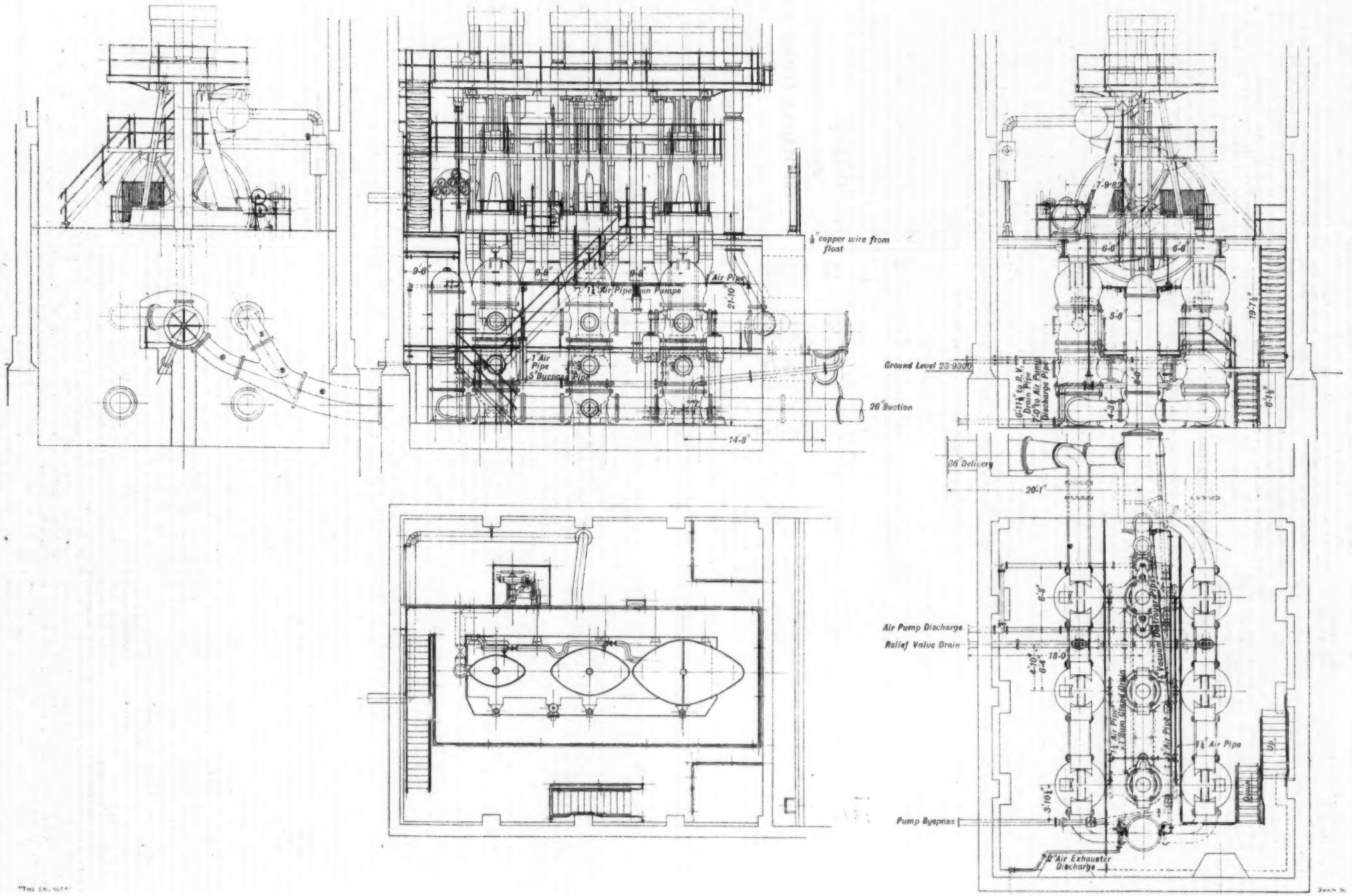
Of particular interest is the direction-finding system, which will enable the navigators accurately to determine their position and course, despite the fact that the compasses will have reduced navigational value in the region of the Pole itself, due to the earth's magnetic field effect and the fact that actually at the Pole all direction will be due south.

THE Corporation of East London, South Africa, proposes to spend £31,000 on an abattoir with chilling-rooms and refrigerating plant.

VERTICAL TRIPLE-EXPANSION WATERWORKS PUMPING ENGINE

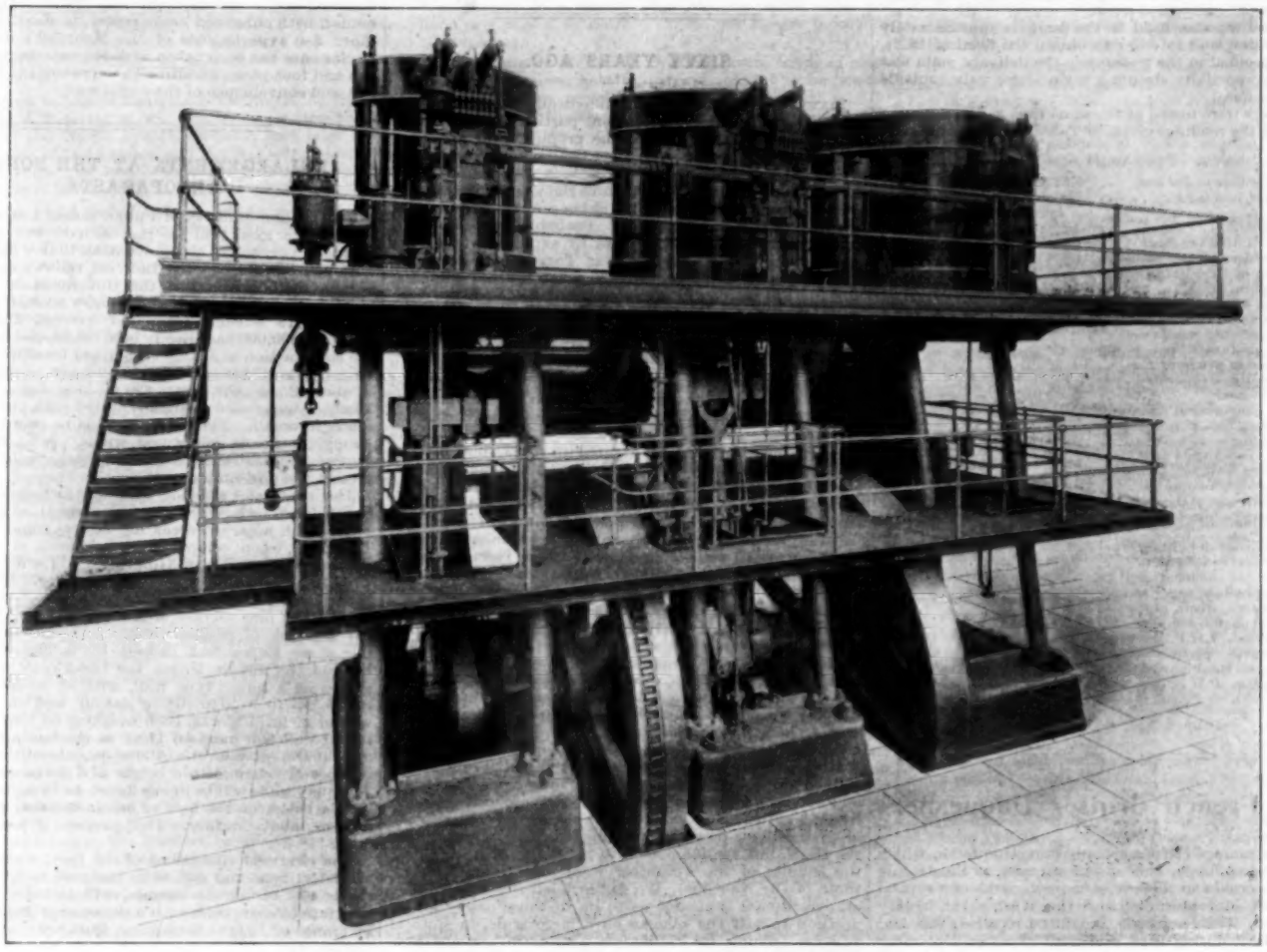
HATHORN, DAVEY AND CO., LTD., LEEDS, ENGINEERS

(For description see opposite page)


1" Air Pipe
5" Bucket Pipe
9-8"
9-6"
9-6"
9-6"
21-10"
14-8"
1" Air Pipe
1" Air Pipe
1" Air Pipe

TRIPLE-EXPANSION WATERWORKS PUMPING ENGINE

HATHORN, DAVEY AND CO., LTD., LEEDS, ENGINEERS



An Efficient Waterworks Pumping Plant.

By the courtesy of Mr. Henry E. Stilgoe, M. Inst. C.E., Chief Engineer to the Metropolitan Water Board, we are able to lay before our readers some excellent results that were obtained in the test of a pumping plant recently supplied to the Board for its Lea Bridge Pumping Station, by Hathorn, Davey and Co., Ltd., of Leeds, and J. Thompson, Ltd., of Wolverhampton. The full figures are set out in the tables given below, but, stated briefly, the main results that emerge from the test are a steam consumption —at 181 lb. per square inch pressure and 124 deg. Fah. superheat—of 10·60 lb. and a coal consumption—Nixon's Navigation Welsh Large—of 1·3 lb. per pump horse-power hour, as calculated by displacement. The steam figure, it should be mentioned, represents total consumption, as far as engine and pumps are concerned, since the air pumps and the air charging pump, though not the boiler-feed pump, were driven direct from the engine. The coal figure, however, also includes boiler-feed pump consumption and other losses.

As will be seen from the above half-tone engraving and from the drawing on the opposite page, the pumping engine is of the triple-expansion inverted vertical type. Its specified duty was to pump from 12,000,000 to 14,000,000 gallons of water per day against a head of from 180ft. to 200ft. The pumps are placed immediately under the steam cylinders, so that the power is for the most part directly transmitted without the intervention of any intermediate mechanism. The mechanical efficiency is consequently high.

A feature of the arrangement is that, as the amount of water dealt with is large, each ram case is provided with two valve boxes. On the air vessels over these six valve boxes are supported the engine girders, the whole plant being thus a self-contained unit resting on the one set of foundations. The ram cases are also tied to the engine girders in such a way that the lift on each top Corliss cover during the working stroke—plus the weight of the moving parts—effectively neutralises the water load on the corresponding ram case; thus neither the steam pressure nor the water load can come on the foundations. Longitudinal mild steel girders are also provided, and into them the ends of the cast iron engine girders fit, so that any valve box column can be removed at will without disturbing the engine bed above it.

The steam cylinders are 24in., 44in. and 66in. diameter by 4ft. stroke, and the maximum speed is 30·5 revolutions per minute. Reheater receivers are provided between the cylinders, which latter are steam jacketed. There are two fly-wheels, placed between the cylinders, and the crank shaft is of the "flexible" type, the joint being at the I.P. crank pin. The valves are of the Corliss type, and are worked by Craig valve gear, with cams and excentrics at cylinder level, operated from a layshaft driven through machine-cut gearing from the crank shaft. The speed can be varied by adjusting the cut-off while the engine is running, the sole function of the governor being to trip the steam valve and spoil the vacuum should the speed exceed any assigned limit. Forced feed lubrication, at two pressures, is provided for all parts under steam pressure, and sight feed lubrication for all bearings and slides.

The pumps are of the outside packed ram type, the ram cases being furnished with thick sleeves so that it would be possible to replace the present 28in. rams with larger ones should more water at a lower head be required at some future time. The suction and delivery valves, which are of the multiple type, are of hard rubber, working on gun-metal grids, and are, as already stated, accommodated in six boxes. The valve plates are separate castings and are so arranged that there are no internal joints between them and the boxes. The valve seats are held down by studs and tripod clamps.

The pumps draw from a well outside the engine-house, which is fed by gravity from an adjacent battery of slow sand filter beds. The delivery water is pumped into a 36in. cast iron rising main, terminating in a balancing reservoir 4 miles distant, but the bulk of the water is passed into the distribution system direct. The surface condenser, which is of large area, is placed on the pump delivery.

The four boilers and superheaters, which were supplied by J. Thompson, Ltd., of Wolverhampton, are of the flat-ended Lancashire type, each being designed to evaporate normally from 3000 lb. to 4000 lb. of water per hour. The plant also includes a Green's economiser. The whole of the steam raising plant formed a contract separate from that for the pumping engine. The leading sizes and particulars of the plant may be summarised as follows:—

Engine and Pumps.

Makers	Hathorn, Davey and Co., Ltd., Leeds.
Quantity pumped per 24 hours	14 million gallons.
Head	200ft.
P.H.P.	590
Engine cylinders	24in., 44in. and 66in. dia.
Rams	28in. diameter.
Stroke, engine and pumps	4ft.
Normal speed	30·5 revolutions per min.
Normal steam pressure	190 lb.—195 lb. per sq. in.
Normal superheat	75 deg. Fah. to 100 deg. Fah.

Steam Raising Plant.

Boilers and superheaters, makers	J. Thompson, Ltd., Wolverhampton.
Number of boilers	4
Number of boilers working	2
Diameter and length of boilers	7ft. 6in. by 26ft. inside of end plates.
Capacity of each boiler, water evaporated	3000 lb./4000 lb. per hour.

Economiser.

Makers	E. Green and Co., Ltd., Wakefield.
Surface area	1600 square feet.

The guaranteed duty of the engine was, as has been said above, that it would pump from 12 to 14 million gallons of water per 24 hours against 180ft. to 200ft. head of water, the steam pressure to be 190 lb. to 195 lb. per square inch, with a superheat of 75 deg. to 100 deg. Fah., and the steam consumption not to exceed 10·9 lb. per pump horse-power per hour by displacement, an allowance of 2½ per cent. to be made to cover errors in measurements.

The test was conducted on July 28th, 1925, by the Board's engineering staff, in conjunction with the contractors. The readings were as follows:—

Table No. I.

Date of test	July 28th, 1925
Duration of test	9 hours
Average pressure by gauge of steam at engine stop valve	181 lb. per square inch
Average vacuum—exhaust steam just entering condenser	27·7in. of Hg.
Average barometer	29·90in. of Hg.
Average temperature of steam at engine stop valve	504 deg. Fah. (124 deg. Fah. superheat)
Average revolutions per minute	28·76
Indicated horse-power:—	
(*a*) High-pressure cylinder	205
(*b*) Intermediate-pres. cylinder	177
(*c*) Low-pressure cylinder	184
Total	566
Average delivery gauge reading	171·4ft. above engine-house floor
Average suction gauge reading	18·6ft. below engine-house floor
Water collected from air pump discharge per hour	4967 lb.
Water collected from jacket and reheater receiver drains per hour	651 lb.
Total consumption per hour	5618 lb.
Hence the following results:—	
Steam consumption per hour per indicated horse-power of engine	9·92 lb.
Steam consumption per hour per pump horse-power, water delivered—slip neglected	10·60 lb.
Mechanical efficiency of pumping engine complete = Pump horse-power / Indicated horse-power × 100 =	93·6

It will be seen from this Table that the actual steam consumption of the pumping engine under test was 10·60 lb. per pump horse-power per hour as against the figure of 10·9 lb. in the guarantee. The improvement over the guaranteed steam consumption was thus 2·75 per cent. without taking advantage of the 2½ per cent. allowance for errors.

In the test the air pump discharge and the discharges from the jacket drains and reheater receiver drains, were measured separately, and are corrected for temperature calibration of the tanks. Readings of steam pressure and temperature, vacuum, delivery and suction head, counter, &c., were taken at 10 minutes intervals, the time for taking them being given by an electric alarm clock. The depth of water level in the suction well below the engine-house floor level was registered by a float recorder in the engine-room, and the delivery head was read from a tested pressure gauge fixed on the delivery side of the pump.

It will be noticed that there is a difference between the water fed to the boilers, as measured by a 2in. Kennedy H.W. meter and that obtained from the air pump and

drain discharges. This difference was due to the consumption of the boiler feed pumps and other auxiliaries, &c. The figure of 1·3 lb. of coal per pump horse-power hour, however, includes the amount burned for all the steam raised, not only for the steam passing through the engine. It is an exceptionally good result.

The actual working head on the pump is approximately 160ft. of water, and in order to obtain the head of 180ft. to 200ft. specified in the guarantee, the delivery main was throttled by partially closing a main sluice valve outside the engine-house.

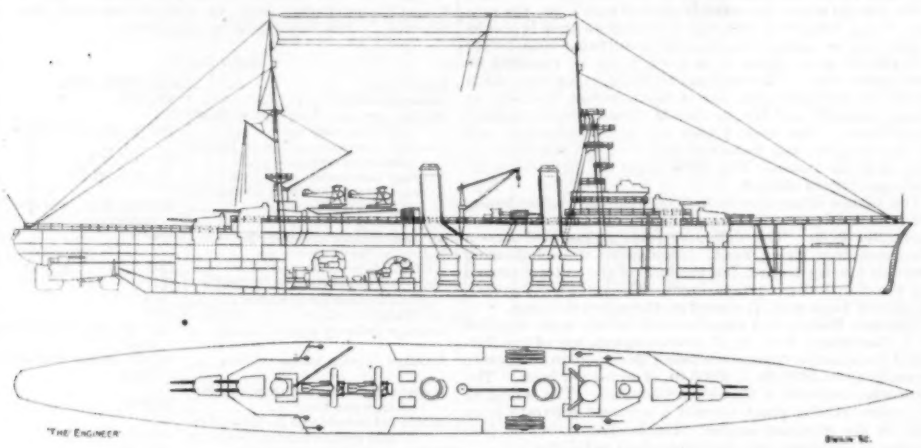
The boilers were tested at the same time as the pumping engine, and the readings given in Table II were obtained.

Table No. II.

Numbers of boilers under test ..	E52 and 53
Description of fuel used	Nixon's Navigation, Welsh, large steam coal
Calorific value	15,006 B.Th.U. per pound.
Weight of coal fired per hour ..	688 lb.
Weight of feed-water per hour ..	6630 lb.
Temperature of feed-water entering economisers	124 deg. Fah.
Temperature of feed-water entering boilers	197 deg. Fah.
Hence the following results :—	
Weight of coal used per pump horse-power per hour	1·36 lb.
Water actually evaporated per pound of coal	9·65 lb.
Equivalent evaporation from and at 212 deg. Fah. per lb. of coal —excluding economisers ..	11·1 lb.
Equivalent evaporation from and at 212 deg. Fah. per lb. of coal —including economisers ..	11·7 lb.
Thermal efficiency of boilers and superheaters—excluding economisers	71·5 per cent.
Thermal efficiency of boilers, superheaters and economisers ..	75·4 per cent.
Overall thermal efficiency coal to water, of boilers, superheaters, economisers, steam pipes and pumping engine complete ..	13 per cent.
Efficiency ratio, I.H.P. as compared with perfect engine working on Rankine cycle ..	72 per cent.
Efficiency ratio P.H.P. as compared with H.P. of perfect engine	67 per cent.

The French Cruiser Duquesne.

The diagram of the French warship Duquesne, which we are able to publish, is of special interest, as illustrating both the internal and superficial characteristics of a typical cruiser built in conformity with the Washington Treaty restrictions. The Duquesne, it will be recalled, was laid down at Brest during 1924, and went afloat on December 17th, 1925. She has a standard displacement of 10,000 tons, exclusive of fuel and reserve feed-water, but as her maximum fuel supply is 1200 tons, it is obvious that she will displace at least 11,500 tons when fully loaded. The leading dimensions are :—Length between perpendiculars, 607ft.; over all, 626ft.; breadth, 63ft.; draught, 20ft. Her propelling machinery consists of four sets of turbines with reduction gearing and eight small-tube boilers, designed for an output of 120,000 shaft horse-power, which is expected to produce a speed of 34 knots. The steaming radii will be 1200 sea miles at 30 knots and 5500 sea miles at 15 knots. As her main armament the Duquesne is to carry eight 8in. guns of a new model, paired in turrets, which are grouped on the centre line as shown in the plan. The turrets are built up of 30 mm. splinter-proof steel. It is understood that no other armour is worked into the ship beyond a thin steel deck over the machinery and magazine spaces. Eight 3in. quick-firers and eight 37 mm. automatic guns form the anti-aircraft armament. Twelve tubes for discharging the new 21·7in. torpedo are carried on triple-deck mountings. Provision is made for transporting two seaplanes, which can be launched from the ship by means of a catapult stationed between the after funnel and the mainmast. The complement numbers 250 officers and 581 men. The Tourville, a sister ship, is shortly to go afloat at Lorient, and the keel of a third vessel has been laid down. A fourth cruiser of the same class is to be put in hand at Brest next October. It is of interest to compare the Duquesne with the Italian cruisers Trento and Trieste, which have also been designed to a standard displacement of 10,000 tons, and were described and illustrated in The Engineer of November 28th, 1924. The Italian ships have machinery of 150,000 shaft horse-power for a speed of 36 knots, but in armament and other features, including the provision of two seaplanes and a launching catapult, they bear a close resemblance to the French type.



THE FRENCH CRUISER DUQUESNE

SIXTY YEARS AGO.

Sixty years ago Ruthven's hydraulic propeller was attracting considerable attention, particularly by reason of its possible application to the propulsion of warships. Hydraulic propulsion, even then, was not new. Dealing with the subject in a leading article in our issue of April 13th, 1866, we stated that down to the year 1857 no fewer than fifty-seven individuals had either proposed or patented the idea in this country alone. Probably the oldest proposal for the propulsion of ships by expelling water from their sterns was, we said, that of Togood, who patented such a system in 1661. In 1730 Allen revived the idea, and in 1738 Bernouilli again proposed it. Ruthven took out his first patent for hydraulic propulsion in 1839. Two vessels were constructed under it. One, a model 9ft. long, was exhibited on the Union Canal, Edinburgh, and the other, a 40ft. vessel built in 1844, on the Forth. In 1849 he patented improvements on the original invention and built a 30ft. vessel, which he exhibited on the Thames. In 1853 the Albert was built in Prussia on Ruthven's system, and in 1866 was still running successfully on the Oder. Ruthven's patent expired in 1863, but his son applied to the Privy Council for its extension, and succeeded in obtaining its renewal for a further ten years. In 1865 he constructed the Nautilus, a vessel of 115ft. length embodying the principle, and on April 7th, 1866, we were afforded an opportunity of examining her construction and of witnessing her trial on the Thames against a paddle steamer, the Volunteer, of similar size and power. Ruthven's system made use of a centrifugal pump with curved vanes. The pump was mounted on a vertical shaft which was driven by a pair of horizontal diagonal engines. Water was drawn through numerous apertures in the vessel's bottom, and was delivered nearly amidships and close to the water line. Valves were provided to deliver the jets ahead or astern. Approximately, 40 to 60 tons of water were passed through the pump per minute. We seem to have been considerably impressed by the performance of the vessel. Four runs on the measured mile at Erith gave her a mean speed of 8·241 knots. From Blackwall to Erith the vessel raced the Volunteer very closely, and eventually drew ahead and beat the paddle steamer by six lengths. No measurements of the coal consumption or of the horse-power of the engines were taken during the trials, but we had reason to believe that, if anything, the engines of the Volunteer were more powerful than those of the Nautilus. We commended the Admiralty—an exceptional thing for us to do in those days—for its decision to test the scheme on a large scale, in spite of adverse opinion in Parliament and in other quarters. H.M.S. Waterwitch, a gunboat of 778 tons burthen, was then under construction at Blackwall, and was being fitted with the latest form of the invention. The results of her trials are well known. Tested against her twin-screw sister ship Viper, she developed a speed of only 9·3 knots on 760 indicated horse-power. Her rival did 9·58 knots on 696 indicated horse-power. Neither speed was good, even in 1866, and the efficiency of both vessels was exceedingly poor. Hydraulic propulsion was revived again in the 'eighties by Sir John Thornycroft, only to fall once more into desuetude until the latter part of the Great War, when one or two inventors reverted to it, primarily with the object of concealing the noise of surface craft from submarines. Two modern systems of hydraulic propulsion were described in our issues of February 11th and 18th, 1921.

SOUTHERN RAILWAY: NEW 4-4-0 TYPE ENGINES.

Fifteen new 4–4–0 type express engines, intended for the Charing Cross, Folkestone and Deal and the Charing Cross and Hastings services, have been recently delivered by the North British Locomotive Company, Glasgow, for the Eastern Section of the Southern Railway. In general design the engines are duplicates of the "L" Class, introduced in 1914, but improvements have been made by Mr. R. E. L. Maunsell in various details. The boiler pressure has been increased from 160 lb. to 180 lb. per square inch, and the cylinder diameter reduced from 20½in. to 19½in., so that the tractive effort is not appreciably affected. The Stephenson link motion has been entirely remodelled, and the valve travel increased to 5½in. in full gear, the lap being increased from ¾in. to 1 3/16in. The engines have the "Maunsell" type superheater header with snifting valves, and the smoke-box arrangement has been redesigned and a standard chimney fitted. The flat-sided tender, with enhanced brake power, is also duplicate with the 2–6–0 type engines of Mr. Maunsell's design. Particular care has been taken with the rearrangement of the cab and foot-plate, resulting in improvement for the comfort and convenience of the enginemen.

ENLARGEMENTS AT THE PORT OF ANTOFAGASTA.

The Chilian Ministry of Public Works has accepted the tender of a local firm for the construction of additional dock and port works at Antofagasta, Chile's largest nitrate port and entrance to the Bolivian railway system. The enterprise forms part of the Government's programme for the development of the country's chief ports. The Antofagasta scheme, estimated to cost £3,000,000—of which £1,800,000 has already been contracted for—includes the construction of a large two-armed breakwater, 1468 m. long, one arm, 648 m. long, running out to sea at a depth of about 25 m., the other, 820 m. long, being in 25 m. to 30 m. of water and running parallel with the coast from south to north. The port will thus be protected against strong south and south-west winds. A second mole, to enclose the sheltering area completely, will be built to protect the port on its north side.

The contract calls for the construction of quayside berths for vessels, with a minimum depth of 10 m. at low water, with adjacent areas for railways and warehouses. The port, when completed, will consist of an enclosed harbour with an area of 31 hectares—77 acres; a berthage with 10 m. of water and 2148 m. long, which may be extended later; and 16·6 hectares—41 acres—of reclamation land. The first section of the breakwater, 220 m. long, will be built of random rubble with concrete blocks on the outer slopes and capped by a concrete parapet. Beyond the 220-m. length the breakwater will be continued as a mixed-type wall, with an understructure of rubble up to 9·40 m. below datum, and on that base a wall of inclined blocks, each weighing 60 tons. The completed wall will measure 11 m. at the base, decreasing to 9 m. at the quay level. Above quay level there will be a parapet of concrete to a height of 7·50 m. above datum. The quay walls will be in blockwork to 10 m. below datum, with a batter on the face of one in ten and a cope set at 3·50 m. above datum. The number of blocks exceeds 8000.

The electrical equipment of the port, which will be of the latest type and especially designed to facilitate rapid movement of nitrate cargoes, will include 36 capstans, 7 nitrate loaders, each with a capacity of 1000 tons daily; 30 cranes of 1500 to 3000 kilos. lifting power; three coal transporters and a Titan crane. The new works must be completed within five years.

Scapa Flow Salvage Operations.—On Tuesday evening, the 13th inst., Cox and Danks, Ltd. were successful in raising the ex-German destroyer G 101 at Scapa Flow. This vessel is the fifth of the larger type of destroyers—each of which weighs about 1300 tons—that the firm has salved, and it is the twenty-fourth salved to date. Only one more destroyer remains to be raised, after which the whole of the firm's staff and plant will be engaged upon the salvage of the 27,000-ton battle-cruiser Hindenburg. In the carrying out of the later operations effective use has been made of the specially adapted floating dock which was described and illustrated in our issue of September 4th, 1925.

The Preservation of Ancient Cottages.—The old cottage architecture of the Jacobean, Elizabethan, and occasionally even earlier centuries, contributes so largely to the unique charm of English villages that the large numbers of persons throughout the country who are really interested in the preservation of these old cottages, and might be willing to co-operate in an organised movement to that end, will be glad to hear that a meeting to discuss the problem is to be held at the Royal Society of Arts, John street, Adelphi, at 4.30 p.m. on Thursday, May 6th. Those interested in the matter, who desire to see some practical steps taken for the preservation of such ancient cottage architecture, are invited to communicate with the secretary of the Society at the above address.

The Institute of Metals.—The annual autumn meeting of the Institute of Metals is to be held in Liége from September 1st to 4th, thanks to the invitation of the Association des Ingénieurs Sortis de l'Ecole de Liége. The meeting will be the first to be held on the Continent since the very successful Ghent meeting of 1913. The following provisional programme has been arranged :—Tuesday, August 31st: Leave London 9.15 a.m.; arrive Liége 7.45 p.m. Wednesday, September 1st: Morning and afternoon, in Liége, members are free to make their own arrangements and to register their arrival; evening, autumn lecture by Dr. W. Rosenhain, F.R.S. Thursday, September 2nd: Morning, reading and discussion of papers; afternoon, works visits, members and their ladies only; evening, civic reception. Friday, September 3rd: Morning, reading and discussion of papers; afternoon, works visits, members and their ladies only; evening, smoking concert. Saturday, September 4th: All-day excursion; conclusion of Liége meeting. Sunday, September 5th: Leave Liége 10.26 a.m.; arrive London 8.30 p.m.

Commercial Motor Users Association.—The annual luncheon of the Commercial Motor Users Association was held at the Savoy Hotel on Thursday last and, as usual, was very well attended. The president, Mr. Edward Shrapnell-Smith, occupied the chair, and the principal guests were the Rt. Hon. Sir William Joynson-Hicks, Secretary of State for Home Affairs, and the Rt. Hon. Sir Eric Geddes. Mr. George Monro, vice-chairman, proposed the health of His Majesty's Ministers in an admirable speech, which turned largely upon the theme "hands off the Road Fund." In his reply, Sir William Joynson-Hicks refused to be drawn upon that subject, but spoke with weight upon the cloud which overhung the industries of the country through the attitude of the miners. He said that it was the intention of the Cabinet to carry out the recommendations of the Royal Commission on Coal. Sir Eric Geddes proposed "The Association," and he, also, spoke in the firmest tones with regard to the sacredness of the Road Fund. He could not believe that a Cabinet which comprised so many members who were in power when the Roads Act of 1920 was passed would fail to play the game, and would rob the road and its users of the funds subscribed for a specific purpose. The Road Fund was committed to an expenditure of thirty-six million pounds, and he relied upon the fairness of dealing of the Cabinet to see that its work was not hampered.

Railway Matters.

THE Bengal Legislative Council has decided to recommend the Government to authorise the railway authorities to make provision in the structure of the Bally Bridge to allow for the construction of roadways for ordinary vehicular and foot traffic, at a cost not exceeding ten lakhs of rupees.

WE regret to have to announce the death, on the 27th ult., of Mr. J. P. Grassick, who was the locomotive superintendent of the North British Railway, and later of the Scottish area of the London and North-Eastern area from January, 1920. He had been with the former company since October, 1886.

THE number of British railway accidents inquired into last year was 24, which compared with 20 in 1924 and 28 in 1923. There were 13 collisions and two derailments affecting passenger trains, and two collisions and one derailment of goods trains. Four buffer-stop collisions of passenger trains and one of a goods train were inquired into, and there was one "miscellaneous" accident—Fenny Stratford. In 18 of the 24 reports recommendations were made.

DURING the year 1924 there were 371 more accidents to railway servants on the Great Western Railway than in 1923. Special efforts were, therefore, made in 1925 to effect an improvement, and so successful were they that the total was 114 less than in 1924. Had the 1924 figures been maintained in 1925 the number of accidents would have been 3370. Instead it was 2832, and the *Great Western Railway Magazine* thinks it fair to estimate that the difference of 538 has been prevented by the co-operative efforts of the staff.

THE Canadian Pacific Railway has prepared plans for the expansion of its system, more especially as regards shipping and hotel accommodation. Two new passenger vessels of the type of the Montclaire, Montcalm and Montrose, and five freight vessels of 8500 tons, with a sea speed of not less than 14 knots, are to be constructed, and will be ready by the spring of 1927. During the past year 68 miles of railway in Western Canada was graded, and 73 miles of track laid. It is proposed to construct sixty-nine more miles of branch lines this season.

ON the afternoon of April 7th an electrically operated train from Partenkirchen to Innsbruck got out of control when descending a steep gradient, and, entering on a sharp curve when running at 70 miles per hour, was derailed and fell down an embankment. Some passengers were seriously injured, but fortunately none was killed. We draw attention to the accident because it appears that the motorman fell from the train. That being so, the question arises as to whether the driving equipment was provided with the "dead-man's handle." Had it been, the want of pressure by the motorman's hand on the controller should have applied the brakes automatically.

THE Leeds and Liverpool Canal Company has recently been attacked on a point that has often brought unjustifiable reproach on railway companies. The latter have often in the past been compelled by clauses, inserted in their Acts of Parliament for new works at the instigation of local authorities, to build bridges over railways, to allow for possible developments. Such bridges generally carry a limited load, and the companies have therefore to warn drivers of traction engines and other heavy vehicles that they must not use the bridge. The remedy usually adopted to meet traffic requirements is for the local authority to take the bridge over. The Leeds and Liverpool Canal Company has many such bridges and has just taken steps to limit the loads passing over them, with the result that road users have thought that some of their rights were being interfered with.

ACCORDING to the Board of Trade returns the value of the railway material exported during the first two months of the present year was as follows, the corresponding figures for 1925 and 1924 being added in brackets:—Locomotives, £851,642 (£561,131, £401,667); rails, £403,486 (£371,156, £438,153); carriages, £272,538 (£346,849, £226,121); wagons, £762,632 (£531,181, £643,906); wheels and axles, £88,707 (£117,986, £125,393); tires and axles, £54,403 (£83,787, £133,394); chairs and metal sleepers, £121,308 (£60,072, £264,366); miscellaneous permanent way, £174,666 (£245,233, £268,871); total permanent way, £842,570 (£878,134, £1,230,177). The weight of the rails exported was 47,031 tons (37,555 tons, 46,596 tons); and of the chairs and metal sleepers, 12,422 tons (4472 tons, 20,591 tons). During February alone the value of the locomotives exported was £467,776, and among the items were:—Australia, £257,515; India, £76,093; South Africa, £46,110; and certain unnamed countries, £79,033. The value of the rails exported in February was £181,329, and among the items were:—South Africa, £33,942; the Argentine, £29,400; India, £23,164; Portuguese East Africa, £18,023; and certain unnamed other countries, £73,465.

IN a dense fog on November 16th last the driver of a passenger train at Hyndland, on the former North British Railway, was given instructions to start on his journey to Glasgow. He could not see the starting signal 110 yards away, so he allowed the train to proceed cautiously until he saw it. As it was at "danger" he stopped the train, but, after a minute, on changing his position on the footplate, he saw the arm go to "clear," but did not observe the green light which should have resulted from the arm being lowered. The train, therefore, resumed its journey, and almost immediately collided with an incoming train that was going through a cross-over road on to an adjoining platform. Such a collision could only have arisen from one or two causes. If the cross-over road was opened when the outgoing train was behind the starting signal, the latter must, by the interlocking, have been "on," and so was passed at "danger." Or the signal, after being at "clear," must have been put to "danger," the cross-over road opened, the signal lowered, and the arriving train travelled 390 yards whilst the outgoing train travelled 100 yards. Lieutenant-Colonel Mount inquired into the accident, and in his recently issued report he expresses the opinion that the signals were against the outgoing train.

Notes and Memoranda.

MODEL experiments carried out in a wind tunnel at Washington show that a wind blowing at 76 miles per hour produces a pressure of 22 lb. per square foot on a tall building.

ACCORDING to Mr. H. B. Creswell, three kinds of engineering structures, held by general consent to be beautiful, are—(*a*) an ocean-going wooden sailing ship; (*b*) a masonry lighthouse built on a rock in the open sea; (*c*) a masonry reservoir, dam or barrage.

AT the present rate, there can be little doubt that the production of the Maracaibo petroleum basin will substantially exceed 30,000,000 barrels in 1926, and therefore, according to Mr. C. M. Hunter, place Venezuela as the fifth, if not fourth largest producer in the world.

IT is claimed that the new reinforced concrete bridge over the river Afan, at Cymmer, which was opened on the 8th inst., is the largest span in Wales and the second largest in the kingdom. It has a span of 160ft., stands 96ft. above the river bed, and has a 20ft. carriageway, with two 4ft. footpaths.

ACCORDING to Dr. P. A. Wagner, the platinum occurrences in the norite zone of the Bushveld complex in South Africa, taken as a whole, constitute the world's greatest primary concentration of that metal, the localities of the deposits being scattered along the norite periphery for nearly 400 miles.

GRAPHITE mining in Canada is, according to the *Chemical Trades Journal*, recovering from the depression from which it has suffered for some years. The industry is now being established on a more healthy and favourable basis, and promises well for the future. Canadian graphite deposits are of good grade. The disseminated flake deposits contain on an average 15 per cent. graphite. The Black Donald deposit is unique, in being the richest known deposit in America, containing over 60 per cent. graphite.

SOME trustworthy values for the melting points of barium, calcium and strontium oxides are given in the *Journal* of the American Chemical Society for February by E. E. Schumacher. Samples from several different sources were heated electrically in a tungsten boat supported on molybdenum rods in pure hydrogen at 0·2 atmosphere pressure. A carefully standardised optical pyrometer was employed to read the temperatures. The results were:—Calcium oxide, 2576 deg. Cent.; barium oxide, 1923 deg. Cent.; and strontium oxide, 2430 deg. Cent.

IN the course of a speech at the annual meeting of the British Aluminium Company, Lieut.-Colonel S. H. Pollen said that the world's annual use of aluminium to-day in tonnage was approaching double the consumption of tin, and the world consumed in greater quantity only three other non-ferrous metals—copper, lead and zinc. The salts of aluminium were more widely and plentifully distributed throughout the earth's surface than those of any other metal, not excepting iron; and this assured an ample supply of the necessary ores from which the metal was produced.

IN the course of a paper read before the South African Institution of Engineers, Mr. H. S. Potter said that the exhaust of the jackhammer, if led into a suitable form of ejector, would materially assist the ventilation in development ends. It only necessitates the provision of a short length of light hose of adequate size from the exhaust of the machine to the ejector chamber. The connection from the ejector to the main ventilating pipe line could be made of flexible rubberised tubing. It will be found, he said, that by using the exhaust in the above manner there will be more chance of the ventilating current reaching the working faces without having to overcome the exhaust air eddying down the drive.

SUMMING up his account of his flight from Rome to Tokio and back, the Marchese de Pinedo told the Royal Aeronautical Society recently that the first stage from Sesto Calende to Melbourne, 14,000 miles, was accomplished in 160 flying hours and took 50 days. The second stage, from Melbourne to Tokio, which included a halt of three weeks at Sydney for an engine overhaul and another also of three weeks in the Philippines, was 8000 miles, and was flown in 90 hours, but occupied 70 days. This was the most difficult section on account of bad weather, inhospitable regions, and long sea crossings. The third stage, Tokio to Rome, was 11,500 miles, and was flown in 110 hours, taking altogether 21 days.

IN the fermentation of sugar less than half of the sugar is actually obtained in the form of alcohol, the remainder of the sugar being converted into carbonic acid gas, which is wasted. The actual cost of fermenting the material and distilling the alcohol is not high. It is estimated by Mr. G. W. Monier-Williams to be about 5d. or 6d. a gallon. Every gallon of alcohol, however, has to carry the cost of the raw material necessary to make it, and this is the prime factor in determining whether it could compete with mineral fuels. It seems, therefore, that under present conditions it would be a difficult matter to produce alcohol from crops in this country for much less than 3s. per gallon in bulk at the distillery, and to this figure must be added the cost of denaturation under Excise supervision, distribution and overhead charges of all kinds.

A SOMEWHAT unusual explosion is recorded in the latest issue of *Vulcan* in connection with a high-speed inverted vertical compound steam engine of the enclosed crank case type, with cylinders 16in. and 29in., stroke 7in., speed 375 revolutions per minute, and employing forced lubrication. The engine itself was not seriously affected, but the building in which it was housed caught fire, and sustained considerable damage. It is conjectured that heating up of one of the slippers in its guide was primarily responsible for the ignition of oil vapour within the crank case. It was the general practice to leave one of the crank case doors slightly open for ventilation purposes, and apparently the door was open at the time of the accident. Oil vapour appears to have emerged from this partially open door and collected under the roof of the engine house in quantity. The primary explosion in the crank chamber appears to have ignited the accumulated gaseous mixture under the roof and caused the ensuing damage.

Miscellanea.

THE Johannesburg Council proposes to expend £300,000 on its gasworks.

A TRADE and Industrial International Fair will be held at Salonkia from May 15th to 31st.

A SPECIAL section for the display of radio-technical instruments is to be organised at the forthcoming Sample Fair at Padua, which is to be held from June 5th to 20th.

PLANS are being discussed in Australia for the production of 180,000 gallons of power alcohol a week from molasses. The factories would be in the Cairns district of North Queensland.

THE output of coal from the mines of Great Britain during the week which ended on April 3rd was 4,633,400 tons, as compared with 5,293,300 tons for the corresponding week of last year.

IT is claimed that a world's record was made by Mr. J. S. Wright, at Brooklands, on the 10th inst., when he rode a twin-cylinder Zenith J.A.P. motor cycle at a speed of 113·45 miles per hour.

IT is probable that the trouble to navigation, which has been caused by the silting up of the Thames near Waterloo Bridge, through the temporary protective works, will be removed by means of dredging.

WHEN she was hurrying to the rescue of the British steamer Lakeham, the Cunard liner Mauretania attained a speed of 29 knots. The Mauretania was built, some twenty years ago, for a speed of 25 knots.

AMONG the ships calling at the port of Antwerp last year, those of British register, as usual, completely eclipsed all other nationalities. British ships amounted to a total of 7,555,576 tons, and our nearest competitor was Germany with 3,109,596 tons.

A SPECIAL committee of the Sheffield Corporation has reported adversely on the Government's Electricity Bill, on the ground that Sheffield will not be benefited and that many of the provisions may cause an increase in the cost of electric current in Sheffield.

ACCORDING to the *Echo de Paris*, the English Government agreed during the Anglo-Italian negotiations, which todk place last January and February, to allow Italy certain concessions in Abyssinia, while in return the Italian Government promised to raise no objection to England using the waters of Lake Tana, from which issues the Blue Nile, for the irrigation of the Soudan.

THE expenditure on canals in Canada, up to the present, has been some 222,000,000 dollars. Figures tabled in the House of Commons show that the capital cost of all canal systems in the Dominion, including those begun before Confederation, was 173,654,882 dollars, up to December 31st, 1925; maintenance, including staffs and repairs, has cost 48,577,903 dollars. Income derived by all canals totalled 14,328,236 dollars.

A NEW field of lignite coal has been found some 45 miles south of Moose Jaw, Saskatchewan, in the Ardill District, on the west bank of the Lake of the Rivers. It is estimated that the coal deposit will yield approximately 4000 tons of fuel per acre, and the area of the coal, while yet undetermined, will be several square miles at least. The main seam is over 4ft. thick and only 80ft. below the surface, and can be mined at a minimum cost.

THE National Federation of Iron and Steel Manufacturers reports that the production of pig iron in March amounted to 568,500 tons, compared with 502,000 tons in February and 607,900 tons in March, 1925. There were 151 furnaces in blast at the end of the month, an increase of five since the beginning of the month. The production includes 179,000 tons hematite, 203,000 tons basic, 141,200 tons foundry, and 20,400 tons forge pig iron. The production of steel ingots and castings amounted to 784,110 tons, compared with 703,800 tons in February and 684,700 tons in March, 1925.

A RADIOACTIVE spa gas from Hepburn, Victoria, was recently analysed by Professor E. J. Hartung and Mr. G. A. Ampt to ascertain its helium content. The volume composition proved to be:—Carbon dioxide, 97·0; nitrogen, 2·55; oxygen, 0·46; inert gas, 0·045 per cent. The last was shown to be a mixture of argon and helium, with traces of neon. Its average molecular weight was 35·1, as determined by an Aston density balance, and corresponded with 13·4 per cent. of helium. The volume concentration of helium in the spa gas was therefore six parts in 100,000. This is the first recorded occurrence of helium in any Australian natural gas.

THE 1925 season was the most successful in the history of the port of Montreal. There was an increase of 337 in the number of sea-going and coasting vessels which docked here, as compared with 1924, while they also represent an increase in tonnage of 1,037,543 gross tons of shipping, as compared with the tonnage for 1924. During the 1925 season the number of sea-going and coasting ships which docked at Quebec totalled 957, this comprising 485 inward and 477 outward-bound vessels. These ships had a total tonnage of 4,791,757 gross tons, representing an increase of over 25 per cent. over the shipping and tonnage of the previous year, during which 620 vessels, with a gross tonnage of 3,764,214, were handled.

NEW regulations, which will come into force on January 1st, 1927, have been issued by the Board of Trade concerning the fire-extinguishing appliances to be provided on ships under survey for Board of Trade passenger certificates. The regulations require the provision of an adequate water service for fire-extinguishing purposes, so arranged that every part of the ship can be reached, portable chemical fire extinguishers for dealing with small fires in passenger and crew quarters, smoke helmet, safety lamps and emergency appliances. In addition, passenger ships using oil as fuel are required to be provided with appliances for discharging froth or foam in the machinery and boiler-rooms. Details of the regulations and recommendations are contained in the Board's pamphlet, entitled "Circular Instructions to Surveyors, No. 1658," copies of which can be obtained directly from H.M. Stationery Office at the usual addresses, or through any booksellers, price 1d. net.

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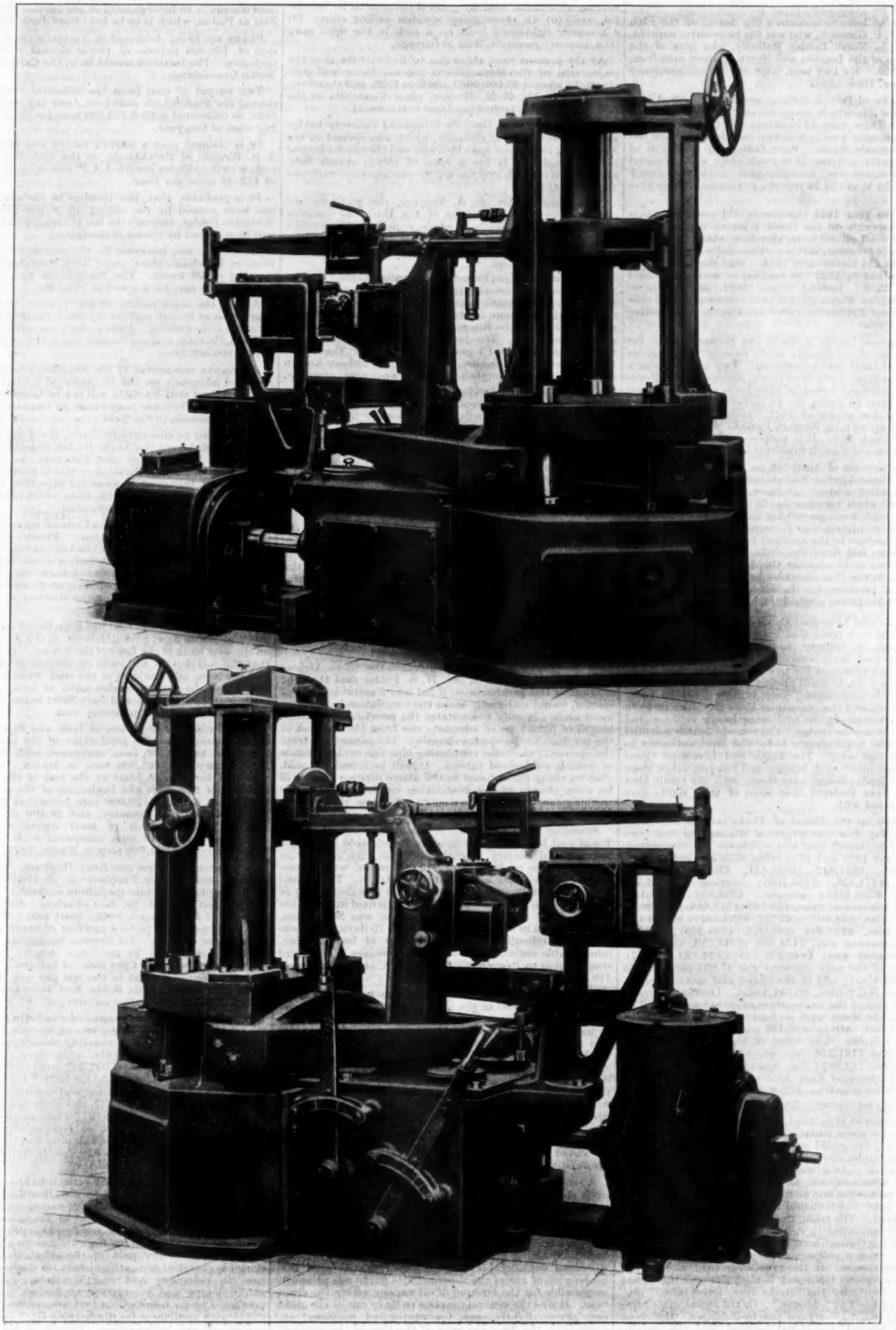

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DEATH.

On the 4th inst., as the result of pneumonia, Mr. WILLIAM THOMAS MOORE, managing director of David Rowell and Co., Ltd., of 14, Howick-place, Westminster, S.W. 1.

THE ENGINEER.

APRIL 16, 1926.

Naval Construction.

Now that two battleships, five cruisers, and several smaller craft—all of the latest design—are completing afloat, while other fighting ships of various types are on the stocks or about to be laid down, the reconstruction of the British Navy on post-war principles may be said to have fairly begun. From a survey of the new material in hand it is evident that no revolutionary changes in the organisation of the Fleet are contemplated. Capital ships still form the backbone of the force, and cruisers retain their traditional value, both as fleet satellites and as guardians of trade. It is true that the new vessels of every class are larger, swifter, and more powerful than their predecessors, but they have obviously been designed for the same functions, strategic and tactical. This can only mean that, in the judgment of our highest professional authorities, the methods of naval warfare remain fundamentally unaltered, notwithstanding the intervention of submarines and aircraft. That view is not peculiar to the British Admiralty; it is shared with equal conviction by the naval experts of the United States and Japan, which countries are developing their fleets on very similar lines. For example, the United States is reconstructing six battleships at heavy cost, and intends to modernise seven more in the near future, while Japan is spending a great deal of money on improvements to her ten capital ships. Thanks to the Washington Treaty, no further vessels of this type may be built before 1931, but it is well known that tentative plans for new battleships and battle-cruisers are being drafted abroad. For the moment, however, interest is centred chiefly in cruiser design, cruisers being outside the numerical restriction which the Treaty imposes on capital units. According to the official "Return of Fleets" for the current year, forty-seven cruisers are under construction or about to be laid down for the seven leading Powers, and thirty-five of them belong to the 10,000-ton "Treaty" class. The British Empire heads the list with thirteen ships of 10,000 tons and one of 8000 tons. The United States has ordered two 10,000-ton cruisers and authorised six more. Japan has four 7100-ton and the like number of 10,000-ton ships in hand. France is completing the three 8000-ton "Duguay-Trouins," is building three 10,000-ton "Duquesnes," and will shortly open credits for the construction of three additional ships. The Italian programme includes five 10,000-ton cruisers, of which the Trento and the Trieste are on the stocks. Russia is making slow progress with the 7600-ton Butakov and Lazarev, of pre-war design; and Germany, having completed the new 6000-ton Emden, is preparing to build three further vessels of that series.

Following the order of precedence established by the "Return," we come to cruiser-minelayers, of which the Adventure is the sole British representative. This vessel, which was launched two years ago, has a displacement of 6740 tons, a speed of 27¾ knots, and an armament of four 4·7in. guns. She will, presumably, carry a large number of mines. It is to be hoped that the £1,500,000 spent on the Adventure will prove a good investment, but we are not very sanguine about it. Here is a ship of relatively large displacement and high cost, yet of mediocre speed and with an armament inferior to that of the latest flotilla leaders. She would be too slow to escape from a smaller but more heavily armed opponent, and if brought to action would fight under a grave disadvantage. Since war experience is held to have demonstrated the importance of high speed in mine-laying ships, we are at a loss to comprehend the reasons which led to the building of the Adventure. She may, of course, embody improvements in machinery, &c., which justify her formidable cost, but so long as the Admiralty's ban on details of new construction is rigidly enforced, it is scarcely permissible even to speculate on the secrets of her design, if any. A cruiser-minelayer of 4000 tons is being built for the French Navy, but no further particulars are available. Of the eight aircraft carriers we possess, all save the Hermes are converted ships, three having been originally designed as light battle-cruisers, one as a battleship and the other three as merchant vessels. They range in size from the Pegasus, of 3070 tons, to the Eagle, of 22,600 tons. Probably the most useful members of the group are the Furious, Courageous and Glorious, which can steam at 31 knots and have a large carrying capacity. Aircraft carrier design represents one of the most perplexing problems of naval construction at the present time. There are grave objections to such mammoth vessels as the U.S. Lexington and Saratoga, of 33,000 tons. Apart from their staggering cost, estimated at £9,000,000 per ship, they offer too vulnerable a target to every form of attack. The loss of one of these ships, with its complement of seventy-two aeroplanes and its vast stores of accessories and munitions, would be a crushing disaster. The Japanese Akagi and Kaga, of 27,000 tons, are open to the same criticism. The design of future carriers will necessarily be influenced by the technical progress of the aeroplane itself, and even more by the improvement of devices for checking the velocity of machines about to land on deck. It is understood that very successful landing operations have taken place on board the Hermes, which has a displacement of only 10,550 tons. For British naval requirements, three ships of the "Hermes" class would be preferable to one gigantic vessel like the U.S. Lexington. No flotilla leaders are under construction or projected in this country, but France is adding many of these vessels to her fleet. Her latest leaders are ships of 2700 tons, with a speed of 36 knots, and six 5·1in. guns. It is not easy to define the *métier* of such craft. They are far too large for torpedo work proper, and needlessly powerful for any of the duties that ordinarily devolve upon flotilla units. We notice, also, that the displacement of the new Japanese destroyers is to be 1800 tons. Our latest destroyers, Amazon and Ambuscade, are of 1330 and 1210 tons respectively, but as these weights do not include fuel or reserve feed water, the actual displacements will be substantially larger. Is it not time that the whole question of destroyer design was reviewed in the light of practical experience? As torpedo carriers, these vessels signally failed to justify their existence during the war. To the best of our knowledge only three major ships were hit by torpedoes fired from destroyers, *i.e.*, H.M.S. Goliath in the Dardanelles and H.M.S. Marlborough and the German Pommern at Jutland. In the latter engagement some two hundred destroyers took part, and many were sunk, but except that the threat of torpedo attack caused the Grand Fleet to turn away shortly after deployment, the direct influence of destroyer movements on the course and issue of the battle was almost negligible. Their most valuable service consisted in putting up smoke screens, a duty that could have been performed equally well by boats of much smaller tonnage. It seems to us that the destroyer has

outlived its utility as an instrument of torpedo warfare, and should henceforth be regarded primarily as an anti-submarine unit. If this premise be granted, it follows logically that the general design of the type stands in need of modification. The displacement might be cut down to 1000 tons or even less, the gun armament retained or strengthened, the torpedo tubes reduced in number or abolished, and the depth-charge equipment increased. The sole justification for large dimensions in vessels of this type is seaworthiness. We believe, however, that a boat of 1000 tons, relieved of the superfluous tophamper with which our present destroyers are burdened, would make better weather of it in a seaway than an overloaded vessel of twice the weight. Merely because other Governments see fit to build so-called torpedo craft of exaggerated size is no reason why we should follow slavishly in their wake.

We should welcome the exhibition of a little more originality on the part of the authorities responsible for the design of our new fighting ships. Unfortunately, the present Board of Admiralty, by choosing to make a profound mystery of everything pertaining to new construction, has rendered both criticism and suggestion equally beside the mark. Much as we would like, in the national interest, to believe that the Royal Corps of Naval Constructors enjoyed an absolute monopoly of experience and skill in the designing of men-of-war, we must regretfully confess to being sceptical on this point. Under existing conditions, however, every new ship ordered for the Navy is planned, built, and completed without any opportunity being afforded for even a superficial examination of the broad features of the design. This might, perhaps, be a defensible policy if we were surrounded by jealous rivals, eager to filch our secrets and overtrump our latest designs, but that is hardly the case at present. The love of secrecy for its own sake is a bureaucratic vice alien to the national temperament, and one which we hope will never be permitted to take root here. We venture to remind the Admiralty that the maintenance of our sea power depends ultimately on the degree of interest which the nation as a whole can be induced to take in the Navy. There are, however, unmistakable signs that public interest in naval affairs is waning, a phenomenon which may be ascribed, in part at least, to the excessive official reticence which has been practised since the war.

Electricity in Mines.

WHILE it is sometimes argued that the more general application of electricity to mining operations would help to alleviate the labour troubles in the coal-mining industry, even in electrical circles this opinion does not receive universal support. Writing on power and the coal crisis in 1925, Mr. J. F. Perry explained that even if the efficiency of colliery plant had been substantially increased, it would have had little effect on the crisis, for the simple reason that the improvements would not have resulted in a saving of several shillings per ton of coal. The assumption that the mines were inefficiently run, from the point of view of power, might, Mr. Perry said, be true to a certain extent, but to assert that that was a contributory cause of the crisis was totally without the backing of fact. The conclusions arrived at by this authority were that the 1925 crisis—and the same remark applies to the present trouble—was essentially a problem of time and wages, which could not be solved without the good will and co-operation of the owners and men; that at least 12,000,000 tons of coal could be saved per annum by the complete electrification of the collieries; that unless the electrification scheme were carefully considered and carried out on sound principles the monetary value of the coal would be considerably exceeded in the process of saving it; and, finally, that the methods of electrification should be left entirely to the colliery companies, which should be free to adopt schemes best suited to individual conditions. With the last conclusion, it hardly need be said, we find ourselves in entire agreement. The present tendency to dictate to colliery owners and others who may contemplate using electricity is apt to retard rather than advance progress. The collieries, like the railways, are expected, although not at present actually compelled, to draw any current they may require from large generating stations, which are supposed to be capable, under practically all conditions, of providing cheaper supplies than those which can be derived from any other source. Legislation may be applied to enforce the economic operation of the mines, but electrification should be considered with respect to each particular colliery or group of collieries, and each individual scheme will not necessarily involve connection with a super-power station or a national bus-bar system.

Last week three papers, entitled "The Applications of Machinery at the Coal Face," "The Design of Storage Battery Locomotives for Use in Mines," and "Electricity in Mines," were read before the Institution of Electrical Engineers by Mr. Sam Mavor, Mr. L. Miller and Mr. R. Nelson respectively. In his paper Mr. Nelson dealt to some extent with this question of the supply of power. Supply from an outside source, whether from a public station or from a neighbouring privately owned station, had not everywhere, he said, commended itself to colliery owners. In the memorandum of evidence before the Royal Commission on the Coal Industry it was given as the considered view of the Council of the Institution of Mining Engineers that unless power companies could supply current at prices very largely below those now in operation the majority of the collieries were right in deciding to continue to produce their own power, either from exhaust steam or by waste heat from other sources or by generating plant using low-priced fuel. In the opinion of Mr. Nelson, the supply should be taken from an outside source whenever two rival estimates show an equal or nearly equal financial result, but it is well to remember that, generally speaking, most collieries could generate electricity at one halfpenny per unit, including all charges. That it is always better to burn coal under the boilers of a super-power station remote from a colliery than it is to burn it at the pithead and generate electricity on the spot is, to say the least, a somewhat remarkable conclusion. We are in no way antagonistic to the super-power station. If its advocates can show beyond all doubt that collieries and other industrial concerns can purchase current from such stations more cheaply than from any other source, by all means let the super-power houses provide the supply; but it is to be hoped that the colliery owners will always be left free to adopt whatever policy they may think fit. There is much to be said for the practice of drawing current from an outside source, provided the consumer can obtain the current at low rates, or at least as cheaply as he can produce it himself. While the application of electricity to mining operations is unlikely to have a profound influence on the labour troubles, electricity should prove a great asset to the industry. As Mr. Mavor states in his paper on the "Applications of Machinery at the Coal Face," the only way to effect a substantial increase of output per man, and consequently a reduction of costs, is to introduce labour-saving machinery. For some reason yet to be explained, the cost of labour per ton of coal stands at a higher figure than the industry can economically afford to pay, notwithstanding that the use of electric and other power in mines continues to increase. Since 1912 the use of electric power alone has increased by over 1,000,000 horse-power; yet the cost of labour per ton is still far in excess of what it should be. In dealing with the mechanical equipment of mines, the report of the Royal Commission on the Coal Industry (1925) states that in 1901 only 1½ per cent. of the total coal output was cut by machinery; but by 1924 the proportion had grown to 19 per cent. Contrary to what many may suppose, the miners are not as a rule opposed to the introduction of machinery, but the problem of fixing new piece rates has always to be solved. Generally speaking, however, if a mine manager seriously wishes to test machinery, he is able to do so, and the position in respect of machinery is therefore hopeful.

Perhaps nothing would do more to make the miner's task less uncongenial than more adequate illumination in the pits, for in many cases he works in semi-darkness. At almost all meetings at which papers on the electrification of mines are read this important question of better illumination arises, and the work of Dr. Thornton in this connection is mentioned. Ever since Dr. Thornton announced that his investigations had shown that alternating current at a periodicity of 150 cycles per second was very much less dangerous than direct current or lower periodicity alternating current, considerable attention has been paid to the question of increasing the standard of illumination in mines, not only on the roads, but also at the coal face. Whether it would be expedient to embark upon improved lighting schemes is, however, at the moment a matter of doubt. Similar experiments to those of Dr. Thornton, recently carried out by Professor R. V. Wheeler in America, have shown totally different results, and before any attempt is made to raise the standard of illumination in fiery pits, by the means of electric lamps supplied with relatively high-frequency, low-voltage, alternating current, the reason for the discrepancy in the results of these two investigations must be explained.

Obituary.

CLAUDE GOODMAN JOHNSON.

KEEN regret will be felt—particularly in the motor world—at the death of Mr. Claude Goodman Johnson, the managing director of Rolls-Royce, Ltd. Mr. Johnson died at his London house on Sunday, April 11th, after a short illness. He was the son of the late William Goodman Johnson, of the Science and Art Department of South Kensington, and was born in Datchet in the year 1864. After attending St. Paul's School he joined the Art School at South Kensington, where his unusual industry attracted the attention of the late Sir Philip Cunliffe Owen. At Sir Philip's suggestion Mr. Johnson took up departmental work, and later he ably assisted Sir Philip during the Fisheries, Health, Inventions, Colonial and Indian Exhibitions of 1883 to 1886. It was his appointment by King Edward to the chief clerkship of the Imperial Institute which brought him at a later date into touch with the motor industry. Mr. Johnson early realised the great possibilities of the then new mode of locomotion, and was one of the founders of the Royal Automobile Club, becoming its first secretary. In that capacity he was responsible for the planning of many of the early motor car trials and exhibitions. It was he, also, who inspired the campaign which was arranged for the education of legislators and county councillors in the utility and safety of the motor car. With the late Mr. Charles S. Rolls, Mr. Johnson became joint manager of C. S. Rolls and Co., which was merged into Rolls-Royce, Ltd. It is with the building up of that world-renowned firm of motor car and aero engine builders that Mr. Johnson's name has more recently been associated. Besides being the managing director of the British firm, he also occupied a similar position with regard to the allied American and French Rolls-Royce concerns.

Literature.

The English Brass and Copper Industries to 1800. By HENRY HAMILTON, M.A., D.Litt. London: Longmans, Green and Co., Ltd. 1926. 18s. net.

THE history of the brass and copper industries in this country is a particularly interesting one, and it is a matter for surprise that so little has been written on the subject. We have Grant-Francis's book on "The Smelting of Copper in the Swansea District," which probably gives most of the material available for the South Wales copper trade, but in an ill-digested form; and Mr. W. G. Collingwood's "Elizabethan Keswick," a most valuable contribution to the history of the Mines Royal Company and of copper mining and smelting in Cumberland, and that is all that one can call to mind in book form. Thirteen years ago a project was on foot in Birmingham to produce, on co-operative lines, a history of the copper and brass trades of this country, but that scheme seems to have fallen to the ground. Now, however, we have before us Dr. Henry Hamilton's "The English Brass and Copper Industries to 1800." At the outset, we may say that it is a valuable and painstaking piece of work, which all those concerned in the brass and copper trades will read with great interest. The author attacks his subject from the economic standpoint; nevertheless, there is a fair amount of information on the technical side, possibly all that is available for the early period, and necessarily he gives us the main facts of the development of the industries.

There were earlier attempts to start the copper industry in this country, but the story really begins in the reign of Elizabeth. Patents were granted to Thomas Thurland and Daniel Höchstetter for mining gold, silver and copper in the counties of Westmoreland, Cumberland, Lancaster, Cornwall, Devon, Gloucester, Worcester, and York, and in Wales; and to William Humphrey and Christopher Shutz for mining in the counties not included in the grant to Thurland and Höchstetter, and for searching for, mining, and using calamine, the ore of zinc then employed in the production of brass. To work these patents two companies were formed, the Mines Royal for the first, and the Mineral and Battery Works for those of Humphrey and Shutz. Both companies received charters and had among their shareholders a number of prominent men. William Cecil (Lord Burleigh), the Earls of Leicester and Pembroke were members of both; but about half the capital of the Mines Royal was furnished by a German firm of merchants. Höchstetter brought over a considerable body of German workmen, and operations were begun in Cumberland in 1565. From that time to the end of 1568 upwards of £18,000 had been expended on mines, smelting houses, cottages for the men, &c., and by the end of 1569 the capital called up amounted to £20,400, and, as Dr. Hamilton points out, it is to

be remembered that at this time money had about eight times the value that it has to-day. By the end of 1571 upwards of £31,000 had been expended, and a valuation of all the ore and copper in hand, the buildings, &c., showed that the assets amounted to £12,000. In 1579 the German firm withdrew from the concern; Höchstetter was calling for more capital, and no dividends had been paid. Copper was being produced, but great difficulty was found in disposing of it. The State demand for copper for bronze guns cannot have been large, in view of the extent to which cast iron guns were being employed, and the cost of carriage must have been a very serious item; the works were in a very remote district, and to bring the copper to London involved the long land transport from Keswick to Newcastle-upon-Tyne, besides the sea transport from that port to London. The company decided to lease the works to Thomas Smyth, one of the shareholders. Smyth carried on until his death in 1591; he also started, under lease from the company, copper mining in Cornwall and copper smelting at Neath in South Wales. This, the first copper smelting works in Wales, had but a short life, and copper mining in Cornwall languished and had ceased before the middle of the seventeenth century. The Cumberland works were carried on until the outbreak of the Civil War, but, except when worked on lease, they produced no return for the company, nor can it be said that the operations in this district contributed in any way to the development of the technology of copper smelting in this country.

The Mineral and Battery Company worked on a much smaller capital (under £7000) than the Mines Royal, and here Dr. Hamilton does not sufficiently distinguish between the two companies. While it is undoubtedly the case that foreign capital was embarked in the Mines Royal, there appears to be no evidence that this was the case with the Mineral and Battery Company. Nor was it at all essential that the brass and battery business should be conducted on a large scale. The chief seat of the industry at this time was Aix-la-Chapelle, and there it was carried on by a great number of small masters, who under the guild regulations were prohibited from owning more than two furnaces each; but these masters not only made brass, but carried on the battery as well, and produced the finished goods, kettles and pans, in addition to plates and wire.

The Mineral and Battery Company was fortunate at the outset in one of its undertakings—the introduction of wire-drawing by power, for which purpose it erected a water mill near Tintern Abbey, Monmouthshire, in 1567. This seems to have been set to work without any particular difficulty, but its operations were confined to iron wire. Possibly its success may have acted as a clog to the company's other projects, for although calamine was discovered in Somerset, and it was said that brass was successfully made in 1568, the company did nothing to establish that industry. It was left for John Brode and his partners, necessarily working under a licence from the company, to do this. Brode set up works at Isleworth, Middlesex, in 1582, where the manufacture of brass was carried on with success for some years. However, difficulties arose between Brode and his partners, and between him and the company, and in the end he was forced to yield up the works to the company. About 1596 another brassworks was set up, under licence from the company, at Rotherhithe, by a Dutchman, and we hear of others at Nottingham and elsewhere.

During the Commonwealth and Protectorate, the activities of both the Mines Royal and the Mineral and Battery companies remained dormant, and in 1649 brass wire mills were set up at Esher, in Surrey, by Jacob Momma and Daniel Demetrius, who got their copper from Sweden. This concern did not continue for any length of time. Later, John Tripp and his partners set up a brassworks near Bristol. At the Restoration, when the companies tried to take up again their monopolies, he was sued by the Mineral and Battery Company for infringement of its privileges; in the end he was permitted to carry on the work under licence. How long he continued to do so is not known. At about this time the two companies were combined, but although they seem to have made some efforts to restart their operations nothing was done, and copper mining and smelting and the manufacture of brass became dead industries, or very nearly so. Calamine was being mined, but for export only; it is even said to have been sent abroad as ballast. Then in 1689 an Act of Parliament was passed which, among other things, had the effect of throwing open the mining of copper. The removal of the monopoly had an immediate effect. The Company of Copper Miners in England was incorporated in 1691, and by the end of that year smelting works were in active operation; Dockwra's Copper Company was founded in 1692, and it was followed by the Derby, the Welsh, and the Cumberland companies, and in 1698 by the Company of Mine Adventurers. Very soon the importation of foreign copper ceased, and instead we were exporting. It is from this period that the copper industry in this country really takes its origin.

Brassmaking was set on foot near Bristol in 1702 by Edward Lloyd and others, with the aid of foreign workmen. About the same time copper smelting was started there by Elton and Wayne, and altogether a good deal of work in the development of copper smelting, the manufacture of brass, and the production of zinc was done in that district. One would like to know a good deal more about it, and about some of the men concerned—say, the Champions and Emerson, who was the first to make brass with metallic zinc—but the whole subject is rather involved, and no doubt the material available is scanty.

There is indeed a good deal that remains obscure about the early days of copper smelting in England. In 1697 Dockwra's Company was said to be producing 80 tons of copper a year—about half the total make of the country—but we do not know where it was smelted. The company had brassworks, battery works, rolling mills and wire mills at Esher, but it is altogether unlikely that copper was being smelted to that extent in that locality. Again, the company of Copper Miners in England was smelting at the end of 1691, but we have no indication as to where it was doing so. Before 1716 it was in possession of works at Lower Redbrook, on the Wye, for in that year it was offering these works for sale, possibly it had already moved to South Wales. The earliest known reference to copper works at Redbrook is of the year 1694, but there were works both at Upper and Lower Redbrook, and which of these the reference concerns is not known. The Upper Redbrook works in 1698 belonged to William Cowper, in 1719 to Thomas Coster, and later they came into the hands of the Bristol Company.

Dr. Hamilton has not much to say about copper smelting in South Wales. The industry seems to have been revived at Neath in 1699; at least, Sir Humphrey Mackworth in 1720 stated that since the year 1699 "considerable quantities of lead . . . and of copper, ingott-brass, brass kettles, and black latten have been made or manufactured" at his works at Neath. Mackworth was connected with the Company of Mine Adventurers, and it was at one of his works that the company smelted the lead ore from its mines in Cardiganshire. It is likely that it did a little copper smelting at the same place, but Mackworth had other works in which he carried on copper smelting and the manufacture of brass and battery. Later on this concern was known as Sir H. Mackworth and Gnoll Company; it came to an end about 1795. This company had rolling mills at Wraysbury, near Staines. We find the Mines Royal Company entering the field once more about the year 1758, when it put up smelting works at Neath Abbey; Grant-Francis, the historian of the South Wales copper trade, was of opinion that the site was that of the original works of 1584, but there are grounds for thinking that he was wrong on this point. At Swansea copper smelting was begun in 1717 by Dr. Lane; the initial venture came to grief, but the industry soon took root, and by about 1790 there were seven smelting works there.

The Temple Brass Works at Bisham Abbey on the Thames was in existence in 1712. By some slip, this works is stated to be in Buckinghamshire. Bisham Abbey is on the south side of the river, and in Berkshire. Great Marlow, the nearest town, however, is in Buckinghamshire.

Dr. Hamilton has been so fortunate as to obtain access to some of the original documents of the Cheadle Company, which he thinks was perhaps the most important brass and copper concern of the eighteenth century. This company started as brass manufacturers at Cheadle in 1719, and from time to time extended its operations, building or acquiring wire mills, battery mills and copper-smelting works.

The Macclesfield Company (Roe and Co.) is of considerably later date. The author thinks it began work in 1757. He is very close to the mark—a copper token issued by the firm in 1791 bears the inscription: "Charles Roe established the copper works, 1758." This company worked mines in Anglesea and Carnarvon, and in Ireland, made copper and brass, and owned rolling mills and wireworks.

The story of the Anglesea mines and of the rise of Thomas Williams is told in a most interesting fashion. There were two mining companies, the Parys and the Mona, both had works for preliminary smelting in Anglesea, and the Parys Company had two smelting works at Swansea; in addition, there were two subsidiary companies, the Stanley Company at Liverpool and the Greenfield Copper Company. Williams was the senior partner, and had sole control of all these, which to all intents and purposes acted as one concern, and it seems had fully half the copper trade of the country.

The chapters on "Amalgamation and Combination" and "Combination in the Copper-mining Industry" deal very ably with the general condition of the trade in the eighteenth century; with the mines and the relation of the mining companies to the smelters; with the combinations of and competition between the smelters, their relation to the brass makers; and, finally, those of the brass makers with the consumers. In 1785 the Cornish Metal Company was formed to buy up the ore from the mines and to have it smelted at fixed rates; it was an unsuccessful venture, and in the end the Cornishmen's great enemy, Williams of Anglesea, had to be called in to straighten out its affairs. It came to an end in 1793, and Williams was then supreme in the copper trade.

The Industrial Applications of Coal Tar Products. By H. M. BUNBURY and A. DAVIDSON. London: Ernest Benn, Ltd. 1925. 42s. net.

THIS book contains a concise and readable account of the purposes for which the products extracted from coal tar are employed in industry. As mentioned in the authors' preface, the subject has been presented from a somewhat novel point of view. The novelty is found in the method of arrangement of the subject matter. The usual practice in books on organic chemistry is to classify substances according to their chemical properties manifested in typical reactions, the various classes being known under generic names. Although nobody questions that this is the most convenient method, and that it provides a comprehensive system, most students of the subject will admit that it leads to a tendency to overlook factors that are of very great significance from the technical point of view, namely, the sources and the technical methods of production of the various substances concerned. Messrs. Bunbury and Davidson have adopted a scheme designed to emphasise the importance of these factors, and they are to be congratulated upon the result of their work.

The book contains fifteen chapters, of which the first serves as a general introduction. In Chapters II. to XIV. inclusive, the primary products of coal tar, such as benzene, naphthalene, and anthracene, and certain important secondary products, such as aniline and beta-naphthol, are described, one in each chapter, with particular reference to their uses as raw materials for the manufacture of numerous derivatives, including synthetic dyes, drugs, and perfumes, explosives, artificial resins, photographic materials, and other products. The relationships between the parent substances and the derivatives are in several instances shown in the form of a geneaological trees; these diagrams are highly instructive, and their introduction into a book of this kind is a very good idea. In Chapter XV. the direct uses of tar itself and of its more important primary products are described.

At the beginning of the introductory chapter it is stated that as a raw material of the chemical industry coal tar ranks second to none in importance. The statement as it stands is open to dispute, for if the industry is considered as a whole, it cannot yet be claimed that coal tar is on equality with such substances as iron pyrites and sodium chloride. Nevertheless, it is true with specific reference to the organic side of chemical industry, and probably the authors intend the qualification to be implied. As a raw material, not only in chemical industry, but also and to a greater extent in other industries, coal tar has now become almost, if not quite, essential to the needs of modern civilisation. In addition to the products named above, tarred roads, motor benzol, patent fuel, industrial solvents, antiseptics, disinfectants, timber preservatives, and many other useful things, have their origin in the foul-smelling by-product of gasworks and coke ovens, which only eighty years ago was considered good for nothing. Then it was a charge upon its parent industry, and a nuisance to everyone who had anything to do with it. Now it is a scurce of handsome profit to its producers and of benefit to all.

The authors have made no attempt to write "popularly," the readers being presumed to have already an elementary knowledge of systematic organic chemistry and of chemical technology. The book should prove welcome to those who are interested in the practice and development of the industry. It is printed in clear type, contains very few errors, and is provided with a fairly complete subject index.

SHORT NOTICES.

Waterworks Administration. By W. H. Parsons. London: P. S. King and Son, Ltd. 1926. Price 18s.—The author is the Chief Revenue Officer in the Secretary's Department of the City of Birmingham Water Undertaking. He has, he says, been greatly struck during his thirty years' experience, both of his own and of other large undertakings, by the remarkable lack of uniformity which exists in waterworks law itself and in its practical application. It is time, he considers, that an attempt should be made to remedy this and other defects. In the present book he therefore sets out his views as to the directions in which he thinks that reform should be made, at the same time explaining that these views are not put forward in the belief that they will meet with general acceptance, but in the hope that they will at least be found worthy of consideration and discussion. He urges that it is the absence of discussion and exchange of views which has led to the present chaotic state of waterworks law and practice, and suggests, that as the British Waterworks Association now affords the necessary link between waterworks undertakings throughout the country, an extensive field of usefulness lies before that Society if it will direct its attention to the reform of the general waterworks law. "If," he says, "the publication of this volume engenders discussion with the view of assimilating and co-ordinating systems and the adoption of the best irrespective of local considerations, the author's object will be achieved."

Practical Surveying. By G. W. Usill. London: Crosby Lockwood and Son. 1926. 7s. 6d. net.—This work, which has now been in existence for nearly forty years, needs little recommendation to civil engineers, but the present edition—the thirteenth—has been considerably improved by revision by Mr. G. L. Leston. For instance, a chapter headed "Miscellaneous Hints and Remarks on the Construction of Plans, the Plotting of Co-ordinates, Traversing, &c.," has been substituted for that on "Colonial Licensing Regulations." The chief merit of the work lies, however, in the great number of hints and descriptions of "dodges" which it contains. They are the result of a long and varied experience on the part of the author.

MULTIPLE-LEVER UNIVERSAL TESTING MACHINE

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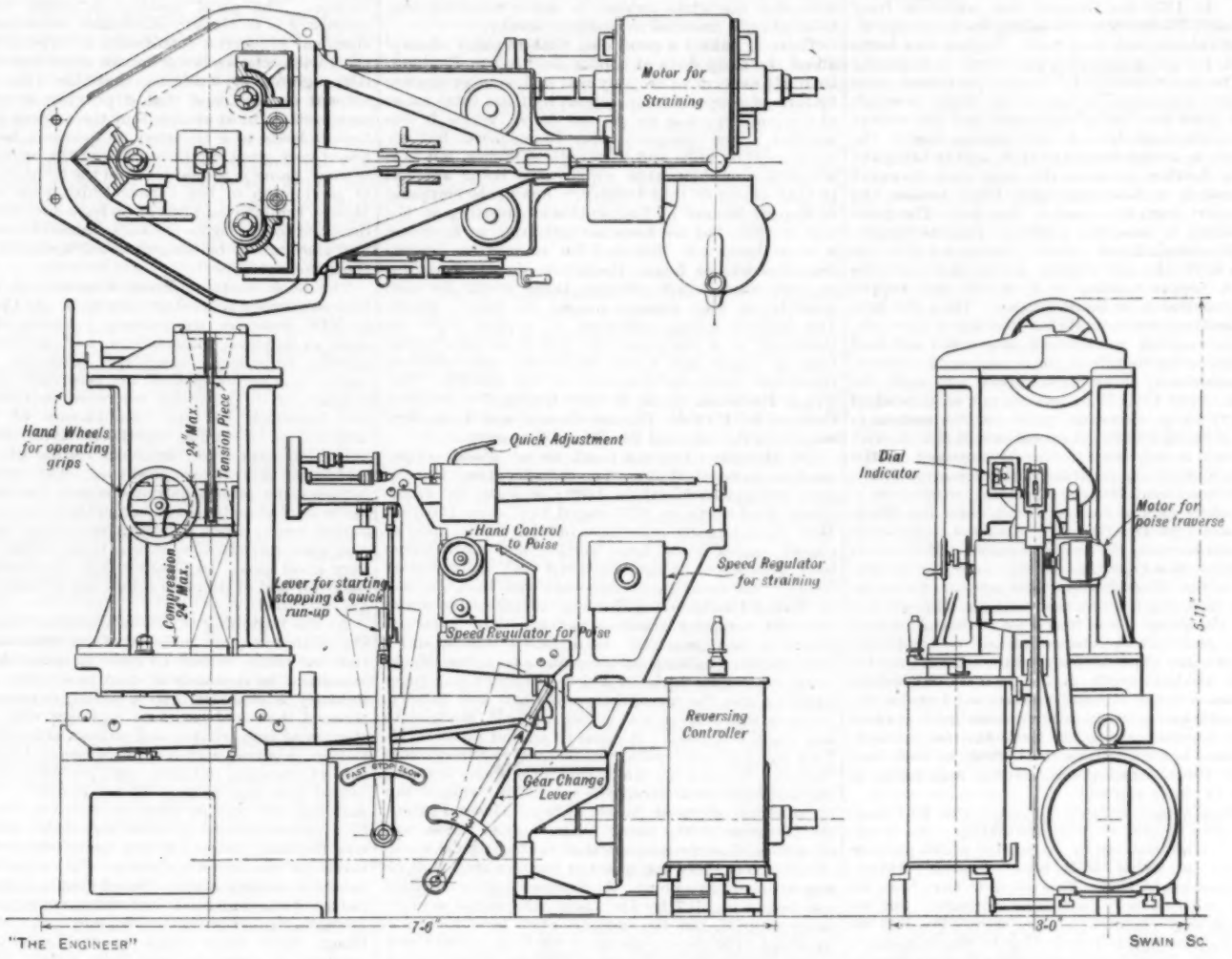


A New Universal Testing Machine.

THE vertical single-lever testing machine, which was originally designed by the late Mr. Hartley Wicksteed, formerly managing director and chairman of Joshua Buckton and Co. Ltd., is a familiar product of that firm, and needs no more than a passing reference here.

There has recently grown up a demand for a universal or general purpose testing machine occupying a minimum of floor space and head room, and capable of carrying out a great variety of tests. To meet this demand Joshua Buckton and Co., Ltd., have produced the new universal machine illustrated by the engravings on page 442 and the drawing above. The general design is of the multiple-lever type, generally used in America, but the details of construction and workmanship are essentially British. The machine shown is of 30,000 lb. capacity, and is capable of testing in tension, deflection or compression any description of materials from nickel chrome steel to timber.

The machine has an upper straining head connected by three struts with the weighing platform. The lower straining head is similarly connected by three screws with the gearing by which the load is applied. By this arrangement of three screws and three struts perfect parallel movement of the straining heads and constant alignment of the specimen is ensured, and a direct pull results. The upper and lower straining heads have open sides for the ready insertion of tension test pieces, and the wedge grips are operated by means of the hand wheels shown, thus avoiding any manipulation by hand of loose gripping pieces.

Compression and deflection are carried out between the lower straining head and the weighing platform, which has a finished flat surface to accommodate any form of die or deflection supports. The upper and lower straining heads and the weighing platform are of steel to give the necessary strength.

The straining screws are of large diameter, working in gun-metal nuts, which are driven simultaneously by cut gears, the drive being transmitted from the horizontal to vertical direction by means of spiral bevels enclosed in the body. The gear-box contains four speed change gears, giving three rates of testing and a quick speed for adjustment. These gears, which are of steel machine cut, run in a totally enclosed oil bath gear-box, and the changes are effected by lever-operated sliding gears, exactly as in first-class machine tool practice. In the machine illustrated the drive is obtained from a 4 horse-power variable-speed motor, which, in combination with the speed changes in the gear-box, gives a wide range of testing speeds with great variety of changes. When a smaller range is sufficient a constant-speed motor may, of course, be substituted.

The weighing apparatus—well seen in all the illustrations—is of the weighbridge type, having compound levers communicating the load to a steelyard, which in this size of machine carries a 10 lb. poiseweight, and is graduated in thousands of pounds. The poiseweight is traversed along the steelyard by a quick pitch beam screw actuated by a hand wheel through a universal joint and wheel and pinion at the end of the beam. There is also provided a graduated disc attached to the gear wheel on the end of the screw, which gives readings from 0 lb. to 1000 lb. by 5 lb. increments.

Small adjustable weights, running on the screw, are provided for re-balancing the beam when the weight of the testing apparatus in use is varied by changing compression and deflection apparatus, &c. The jockey weight is connected with the beam screw by a lifting nut and hand lever, so that it can be instantly disengaged and slid back to zero or to any desired point, the jockey weight itself running on three rollers, all of large diameter, to reduce friction. When required—and this provision was made in the machine illustrated—a small motor is fitted to drive the beam screw through variable speed gear, so as to give a constant rate of application of the load. It is therefore possible to set the driving motor and gear to give a constant rate of pull, and then keep the beam balanced by hand, or to set the jockey weight motor and gear to give a constant rate of application of load, and then to keep the beam balanced by varying the speed of the main driving motor, either of these facilities being employed according to the nature of the test being carried out.

The Quarter's Shipbuilding Returns.

LLOYD'S REGISTER shipbuilding returns for the quarter ended March 31st, show that the tonnage under construction in Great Britain and Ireland—843,070 tons—is nearly 42,000 tons less than at the end of December, 1925, and about 322,000 tons less than the tonnage being built twelve months ago. The tonnage on which work was suspended at the end of March, 1926, amounted to nearly 80,000 tons, as compared with 74,000 tons at the end of March, 1925. The present totals are the lowest recorded since September, 1909, and are 1,047,000 tons below the average tonnage building during the twelve months immediately preceding the war, *i.e.*, 1,890,000 tons. An appreciable increase is, however, shown in the tonnage commenced during the quarter, namely, 193,121 tons, as compared with 160,986 tons during the fourth quarter of 1925, but the tonnage launched during the past quarter—190,705 tons—was 25,776 tons lower than that for the previous three months.

The total merchant tonnage being built in other countries—1,167,136 tons—is about 17,000 tons less than at the end of December, 1925. The figures for the leading countries abroad are:—Italy, 298,530 tons; Germany, 216,871 tons; France, 155,965 tons; Holland, 133,605 tons; and United States, 117,777 tons. From one of the tables it is seen that 194,343 tons were commenced abroad and 269,868 tons were launched, an increase as compared with the previous quarter of 12,053 tons in the tonnage commenced and a decrease of 4971 tons in the tonnage launched.

The total world tonnage under construction—2,010,206 tons—shows a decrease of 59,339 tons as compared with the previous quarter and is 1,436,352 tons below the highest pre-war record reached on June 30th, 1913, viz., 3,446,558 tons. There are at the present time under construction in the world twenty-three vessels of between 10,000 and 20,000 tons each and eleven of 20,000 tons and upwards. Eleven out of the twenty-three and three of the larger vessels are being built in Great Britain and Ireland. The returns show that there are at the present time thirty-six steamers and motor ships, each of over 1000 tons, with a total tonnage of 247,510 tons, under construction in the world for the carriage of oil in bulk. Of these tankers, fifteen of 91,810 tons are under construction in Great Britain and Ireland, eight of 57,000 tons in Holland, and five of 44,000 tons in Germany.

The tonnage of vessels now being built in the world, which are to be fitted with internal combustion engines, amounts to 913,099 tons, while the tonnage of steam vessels under construction is 1,078,236 tons. The motor tonnage is thus 84¾ per cent. of the steam tonnage. The tonnage of motor ships being built at the end of March in Great Britain and Ireland—289,664 tons—amounted to 52·7 per cent. of the steam tonnage under construction. In Denmark, Holland, Italy, Japan and Sweden the motor tonnage under construction greatly exceeds the steam tonnage; the combined totals for those five countries being 135,640 tons of steamers and 453,903 tons of motor ships. The world figures include sixty-two motor ships, each of between 6000 and 10,000 tons; five of between 10,000 and 15,000 tons; five of between 15,000 and 24,000 tons; and one of about 33,000 tons.

The total horse-power of the engines being built or installed on board vessels at the end of March, 1926, amounted to 1,528,879 horse-power, of which 612,678 horse-power are being or were built in Great Britain and Ireland, 182,204 horse-power in Germany, 172,960 horse-power in Italy, 144,500 horse-power in France, 129,867 horse-power in the United States, and 286,670 horse-power in other countries. Excluding 147 engines of less than 500 horse-power each, the average horse-power of each set reaches 3186 horse-power; the average for reciprocating steam engines being 1729 horse-power, for oil engines 3812 horse-power, and for steam turbines 9293 horse-power.

Of the vessels under construction in the world, 295 of 1,363,943 tons are under inspection of the Society's surveyors, with a view to classification in Lloyd's Register Book.

THE flying boat Widgeon, which was officially tested at Sydney, N.S.W., on April 7th, attained an average speed of over 102 miles per hour.

The Canal de Castilla Irrigation Schemes.

THE works of restoration and improvement of the ancient Canal de Castilla, which have rendered it a useful navigation canal, were described, with a map, in THE ENGINEER, page 340, October 2nd, 1925. The irrigation works referred to in that description as a further development of that waterway are discussed by Mr. Casimir Juanes in the *Revista de Obras Publicas*, February 15th, 1926.

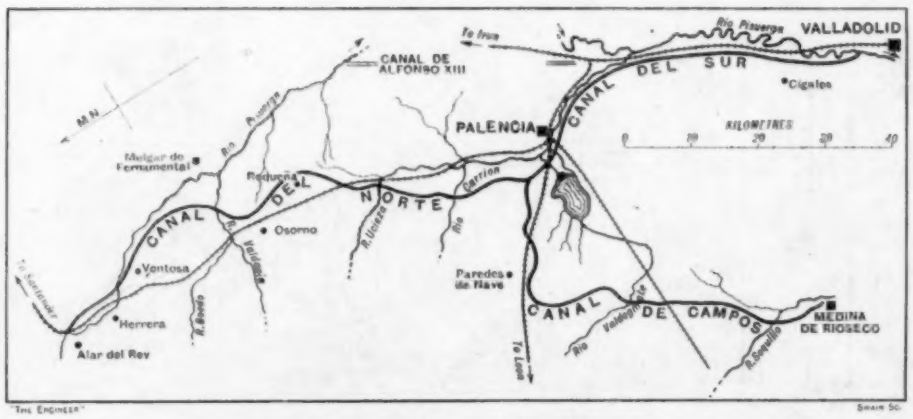
There are, it seems, two conceptions of the canal as an agent for irrigation. According to the first, the method, based on the natural conditions, would be such as fully to utilise the fall of the river Pisuerga between Alar del Rey and Valladolid, all the available water being spread over the intervening and adjoining lands. A project entirely independent of the existing canal is not contemplated. To adapt the northern branch for the full supply would involve increasing its capacity from the present 2·0 cubic metres per second, or mecusecs * to 24 mecusecs or the irrigation of the desired area of 56,000 hectares.† For a part of its course the canal would have to be widened from its present width of 14 m. to 80 m., in order to give it a cross-section of 120 square metres. For the remainder of its length this branch would have to carry a flow ranging down to 12 mecusecs, and the other branches would have to be modified, the Campos, or South-Western branch, to take 9 mecusecs and the Southern branch to take 3 mecusecs. The present velocity of flow in the Northern branch is only 0·2 m.p.s., and the modifications would include some raising of water levels, would embarass navigation and cause some other inconvenience at locks.

The considerations have led to the adoption of a scheme based in part upon the use of the canal as a distributor of local storage, contemplated but not yet provided for; but mainly upon the construction of canals taking off at various points from the rivers and the canal. The Northern branch will be used to supply, directly a narrow strip extending to its crossing with the Pisuerga. This work has been done, the irrigable area being 870 hectares. Next, the Canal del Pisuerga, having its intake near the crossing of the Canal de Castilla with the Pisuerga, upstream of Ventosa, will traverse the lands lying between the former and the latter, as far as the junction of the rivers Ucieza and Carrión, irrigating 20,000 hectares in its 69 kiloms. length. This project has been approved in principle and is being studied. Ten small canals, ranging in length from 3 to 12 kiloms. will take off from the Canal de Castilla, Northern branch; the longest being now in course of construction. They will irrigate 6400 hectares.

Proceeding southward, the next canal, already constructed and in operation, is the Acequia de Palencia, commanding 6000 hectares. Its intake is on the river Carrión at the junction of that stream with the navigation canal, and after crossing the railway it flows nearly parallel with the line and ends near the junction with the line to Irun. For the irrigation on the right bank of the Carrión, as far as the outskirts of Palencia, a canal 15 kiloms. long is being made; and it is intended that 6000 hectares between the Canal del Sur and the Pisuerga shall be irrigated by short canals from the former, the tract extending from the word "del" on the map to the end of the canal near Valladolid. It is intended that the Campos branch shall provide for the irrigation of 6000 hectares by means of a series of similar short canals, totalling 48 kiloms. in length, the series extending from near the junction of the three branches of the navigation canal to the river Valdeginete, and another series is proposed for the tract beginning at the initial letter of "Campos" and ending at Medina de Rioseco.

The area irrigated in the great bend of this Campos branch may be extended to a little beyond the Valdeginete and the railway which twice crosses it, by an additional 4000 hectares irrigated by a canal along the margin of the zone and taking off almost exactly at the "n" in "Valdeginete"; but whether this canal can be supplied with water from that river is not stated. The total length of the canals referred to, and not including minor channels served by them, is nearly 300 kiloms., or 186 miles. Of this total 57 kiloms. have been constructed and a further 15 are in hand. The estimated cost is nearly 18 million pesetas, or, at the present rate of exchange, some £530,000. The rate is therefore, for the 56,000 hectares or 138,000 acres, say, 321 pesetas per hectare irrigated, or £3 17s. 0d. per acre. Supposing that the water supplied were to increase by only 10s. per acre the value of the crops grown in a year, the increase would amount to nearly £70,000 per annum, or, at 5 per cent., would represent a capital value of £1,400,000, say, 2½ times the estimated cost of the works.

Apart therefore from the construction of storage reservoirs, which is not yet authorised, the finance of the project seems to be beyond cavil. The irrigable areas, including the one large block with its lagoon, appear to be excellently situated as regards the important matter of provision for drainage. The only present intimation of the kinds of crops which are to be grown is contained in the descriptive epithet "fertile granaries."



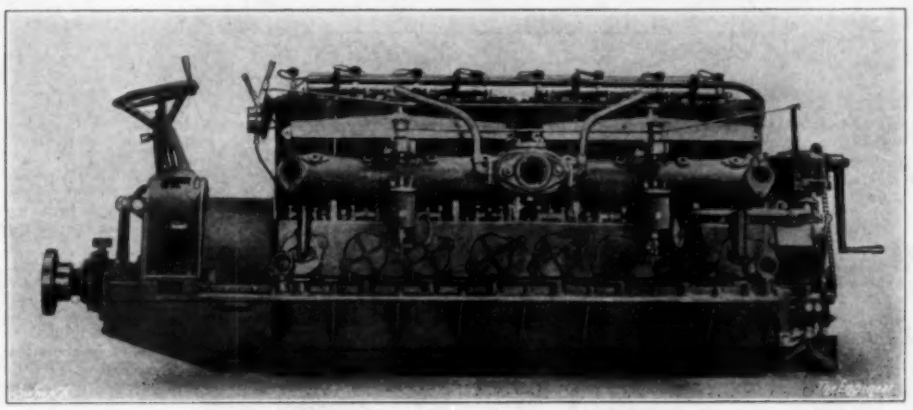
THE THREE BRANCHES OF THE CANAL DE CASTILLA

* 1 cubic metre = 220 gallons; 2 cu. m. per sec. = just over 38 million gallons per day.

† 1 hectare = 2·47 acres; 56,000 hectares therefore = 138,320 acres.

An Eight-cylinder Marine Oil Engine.

TESTS were recently made at the Southampton Works of the Parsons Motor Company, Ltd., on the first eight-cylinder marine oil engine built to the firm's new design. The engine with its reverse gear is shown in the accompanying illustration. It has eight cylinders, each 4¾in. in diameter with a stroke of 6in., and is designed for an output of 56 brake horse-power on paraffin fuel and 70 brake horse-power when using petrol, running at a normal speed of from 900 to 950 revolutions per minute.



56-70 B.H.P. EIGHT-CYLINDER PARSONS MARINE OIL ENGINE

The general construction follows the standard practice for the firm's new type of engine, which was described and illustrated in our issue of July 17th, 1925. Separate cylinders are used and the crank shaft is supported by a bearing at each side of the crank throws. Forced lubrication is fitted and the lubricating oil is carried in cast passages formed in the bed-plate, so that there are no lubricating pipes within the crank case. A high-tension magneto with an impulse starter is used, and the speed of the unit is controlled by a totally enclosed governor operating an independent throttle valve which cannot be put out of action by the hand controls reserved for speeds below the governor speed. It will be seen that the gear drives for the magneto, governor, oil pump and water pump are all conveniently arranged at the forward end of the engine, where an accessible strainer for the lubricatng oil system is also placed.

The engine referred to is arranged for running on paraffin fuel and two vaporisers, each serving four cylinders, are fitted. A water-jacketed casting connects the exhaust outlets from the two vaporisers so that only a single exhaust pipe is required. At the after end of the unit a Parsons standard reverse gear is built on to the extended bed-plate casting. A cone clutch of large diameter serves for the ahead drive, and when running astern the drive is taken through bevel wheels, while a brake band is also provided.

Trials made with this unit have, so the makers inform us, shown that the engine possesses a wide range of power with considerable flexibility, whilst the vaporising system permitted the running of the engine on paraffin, well throttled down, and with no load, over a considerable period. Further trials, both above and below the designed speed, were successfully carried out, and throughout smoothness of running with even torque and absence of vibration were, we learn, noticeable features of the test. The scantlings of the engines and gear are, so we are informed, in excess of the requirements of Lloyd's and the Board of Trade, whilst all engines built by the firm are designed to pass the new S.M.M.T. test which has been recently introduced and was referred to in our issue of March 12th.

Iron and Steel Institute.

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, May 6th and 7th, 1926, commencing each day at 10 a.m.

The following is the programme of proceedings:—On Thursday, May 6th, at 10 a.m., there will be a general meeting of members, at which the annual report and statement of accounts for 1925 will be presented, and the newly elected President, Sir W. Peter Rylands, will be inducted into the chair. The Bessemer Gold Medal will then be presented to Sir Hugh Bell, Bart., after which the President will deliver his opening address. The following papers will then be considered:—Report on "Heterogeneity of Steel Ingots," by a Sub-committee of Committee No. 5, consisting of Dr. W. H. Hatfield (chairman), T. P. Colclough, W. J. Dawson, J. H. S. Dickenson, A. P. Hague, E. F. Law, S. A. Main, T. M. Service, and J. H. Whiteley; J. H. S. Dickenson, "A Note on the Distribution of Silicates in Steel Ingots"; and J. H. Whiteley, "Ghost Lines and Banded Structure of Rolled and Forged Mild Steels." At the afternoon session, which will commence at 2.30 p.m., the discussion of the morning's papers will be continued, and if time permits a paper by W. H. Dearden and C. Benedicks, entitled "Magnetic Changes in Iron and Steel below 400 deg. Cent.," will be presented and discussed. At 7.30 p.m. the annual dinner of the Institute will be held in the Grand Hall, Connaught Rooms, Great Queen-street, W.C.

On the Friday, May 7th, at 10 a.m., the general meeting of members will be reopened, and the announcement made of the award of the Andrew Carnegie Research Scholarships for 1926–7. The following papers will then be presented for discussion:—D. Brownlie, "Coal Blending"; W. W. Hollings, "Notes on the 'Combustibility' of Coke, and Direct Reduction in the Blast-furnace"; W. Rosenhain, R. G. Batson and N. P. Tucker, "Effect of Mass in the Heat Treatment of Nickel Steel"; and G. R. Woodvine and A. L. Roberts, "Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters." At the afternoon session the two following papers will be considered:—I. G. Slater and T. H. Turner, "The Hardness of Carbon Steels at High Temperatures"; and A. R. Page, "The Hardening and Tempering of High-speed Steel." The following additional papers will also be presented to the meeting, and if time should not permit of their being read and discussed, discussion by correspondence will be invited:—A. E. Cameron and G. B. Waterhouse, "The Effects of Arsenic on Steel"; E. D. Campbell and H. W. Mohr, "Specific Resistance and Thermoelectro-motive Potential of Some Steels Differing in Carbon Content"; R. H. Greaves and J. A. Jones, "The Ratio of the Tensile Strength of Steel to the Brinell Hardness Number"; H. O'Neill, "Deformation Lines in Large and Small Crystals of Ferrite"; A. Osawa, "The Relation between Space Lattice Constant and Density of Iron-nickel Alloys"; and T. E. Rooney and L. M. Clark, "The Estimation of Phosphorus in Steels containing Tungsten."

The autumn meeting of the Institute will be held, by invitation of the directors and members of Jernkontoret (Swedish Ironmasters' Association), in Stockholm, on Thursday, Friday and Saturday, August 26th, 27th and 28th, 1926. The following programme, which, however, is subject to revision, has been arranged:—On Thursday, August 26th, a reception in the House of Jernkontoret will be held in the evening, at which the General Reception Committee will welcome the President, members and ladies. The morning meeting on the Friday will be devoted to the reading and discussion of papers. Arrangements will be made for visiting industrial enterprises in Stockholm in the afternoon. In the evening Jernkontoret will entertain its guests at dinner. On the Saturday, the morning meeting will again be devoted to the reading and discussion of papers.

On the Sunday groups of members will leave Stockholm in the evening for the purpose of visiting ironworks and mines to the north and west of Stockholm. The groups will return to Stockholm or Gothenburg in the evening of Wednesday, September 1st.

LESS than a pound of silicate of soda hardens and dust-proofs a square yard of concrete surface.

The Rugby Wireless Station.

On Wednesday, April 14th, Mr. E. H. Shaughnessy read a paper before the Wireless Section of the Institution of Electrical Engineers on the Rugby radio station of the British Post Office. The paper is divided broadly into three sections—power plant, high-frequency generating valve plant, masts and aerials—but as we have already published a good deal concerning the first and third items of the installation, we propose to give in this instance an abstract of that section of the paper which is devoted to the high-frequency generating valve plant, which was designed to utilise thermionic valves and to be capable of dealing, if necessary, with an output to the aerial of 500 kilowatts continuously under commercial conditions.

High-frequency Generating Valve Plant.

For the purpose of preliminary calculations the wave length was taken as 18,000 m., the capacity of the aerial as 0·045 μF, and the total aerial circuit resistance as 1 ohm.

The aerial was designed so that it could be used as one large aerial or be readily divided at the station building into two unequal parts to provide for simultaneous telegraph transmissions on two aerials, and for this purpose two separate down leads were provided.

The high-frequency generating plant had therefore to be designed so that it could be readily used for such simultaneous transmissions when necessary. However, after the plans had been prepared it was decided to carry out experiments in transatlantic telephony from Rugby in association with the American Telegraph and Telephone Company, and the smaller part of the aerial has been reserved for this purpose for the present, and so diverted from its intended function of forming part of a large aerial for the full telegraphic power of the station, or of being used for a second radio telegraphic channel.

In consequence, the aerial immediately available for the telegraph transmitter is the larger part erected on eight masts, which has a capacity of 0·033 μF.

It is essential with the ever-increasing number of transmitting stations that special efforts should be made to maintain constant the frequency of a radio transmitting station, and thus reduce the possible interference to a minimum by permitting the use of highly selective receivers.

It was therefore decided to investigate and, if possible, develop the use of the valve-maintained tuning fork of Eccles and Jordan as a primary source of constant oscillations. The Post Office research staff produced a suitable combination which was tried out commercially at the Post Office Northolt valve station, and proved successful.* The primary source or master oscillator at Rugby is a valve-maintained tuning fork, having a frequency of about 1800 cycles per second, this frequency being adjustable within small limits, and the high frequency required for controlling the main set is obtained by selecting the ninth harmonic of the tuning fork frequency.

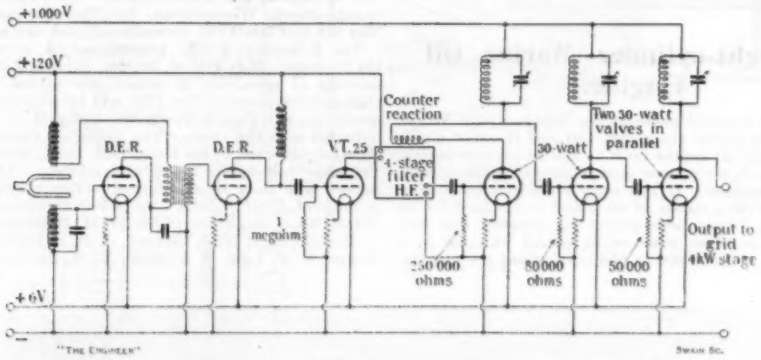


FIG. 1—DIAGRAM OF TUNING-FORK UNIT

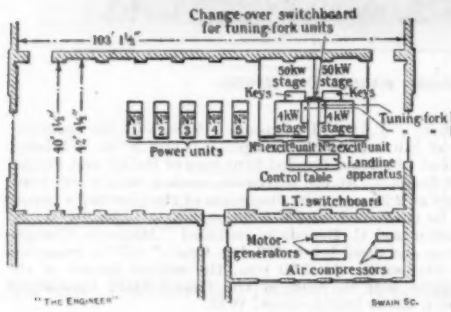


FIG. 2—PLAN OF TRANSMITTING BUILDING

The output from the tuning fork unit is amplified three times before it is delivered to the aerial circuit, the various stages being designed to deal with input powers of the order of 4 kW, 50 kW, and 1000 kW respectively, and giving output powers of 2 kW, 30 kW and 540 kW respectively. These are referred to as the 4-kW stage, the 50-kW stage and the "power units" respectively. The combination of the 4-kW stage and its associated 50-kW stage form an "excitation unit." Excitation units and tuning-form units are provided in duplicate so as to reduce to a minimum the possibility of delay due to faults, and the arrangement is such that either tuning-fork unit can be used with either excitation unit and either excitation unit can be used to drive the final stage of amplification, which consists of a number of power units.

All the stages and units are contained in high-tension enclosures. The arrangement has been planned so that all meters can be read conveniently, and so that such tuning adjustments as are necessary while the power is on can be made from outside the high-tension enclosures.

Fig. 2 is a plan of the ground floor of the transmitting building, and shows the lay-out of the high-frequency generating plant, &c. The excitation units are seen in duplicate on the right and the five power units on the left.

The switchboard immediately behind the control table is a twenty-panel switchboard, which is associated with the filament supply to the amplifiers and the machines in the auxiliary machine-room immediately behind this switchboard, which supply the power for the earlier stages of amplification in the tuning-fork unit, the grid bias voltages, compressed air pump motors, &c. The main high-tension direct-current switch is remote-controlled from the control table.

The final stage of amplification—*i.e.*, the power units—is not provided in complete duplicate as in the earlier stages. The power station practice of having a number of units capable of being worked in parallel on common bus-bars has been adopted.

* A. G. Lee, *Electrician*, 1925, Vol. 94, page 510.

High-tension Direct-current Supply.

The excitation units and the power units are designed to utilise the same voltage high-tension direct-current supply, and a simple arrangement permits this high-tension supply to be switched on to the 4-kW stage, the 50-kW stage and whichever power units are in use, by the pressing of a single button on the control table, and ensures at the same time that all accessible units are "dead."

The general scheme adopted is as follows:—

(1) A change-over switch is provided which connects the high-tension supply to one or other of the excitation units.

(2) The high-tension supply is fed through the excitation unit to the bus-bar supplying the power units.

(3) All the safety switches and devices form a "series" circuit with the "holding coil" circuit of the high-tension direct-current switch, which is remote controlled from the control table.

(4) The change-over switch of (1) also makes the necessary transfers in the control wiring of (3) as between the excitation units.

General Scheme of Circuits.

Fig. 3 is a skeleton diagram of the circuit arrangements from the output of the tuning-fork unit to the aerial, showing the circuits between the 4-kW stage and the 50-kW stage, between the 50-kW stage and the power units, and between the power units and the aerial. The tuned high-frequency circuits at the various stages are indicated by the thick lines. A particular characteristic of the circuits is the use of a single tuned circuit between one stage of amplification and the next, and the use made of capacitative coupling for giving the necessary voltage variations on both anodes and grids.

Fig. 4 is a schematic diagram showing the method of feeding the high-tension direct-current supply through a selected excitation unit to the power units by means of the bus-bars, and the method of paralleling the power units by means of the same bus-bars. It will be observed that there are three bus-bars running the length of the installation for the anode, grid and filament (earthed) respectively, and that to bring a particular unit into operation in parallel with others, it is only necessary to connect it to the bus-bars of one three-way switch, and to light the filaments by means of the filament switch for that unit.

In order to simplify this system of paralleling, all apparatus proper to the complete amplifier formed by the power units as a whole, such as anode choke, grid leak, &c., are provided in duplicate and placed inside the respective excitation units.

Filament Supply.

The filament supply for the power units and the 50-kW stage is at 416 volts, three-phase, 100 cycles, transformed down to the required voltage for the filaments—about 20 volts—by transformers in the units themselves. A Tirrill regulator is provided for the 416-volt supply to keep the voltage on the valve filaments constant, this being very important from the point of view of conserving the life of the valves. The filament load of each power unit and each 50-kW stage is balanced between the three phases so as to reduce the effect of any periodic change of emission current due to the use of alternating current for filament heating.

The filament supply for the 4-kW stage is at 15–20 volts direct current, supplied by one of the generators in the auxiliary machine room.

The Excitation Unit.

The 4-kW stage utilises glass valves of the so-called 600-watt type—*i.e.*, capable of a dissipation of 600 watts—and the panel can be equipped with one, two or three of such valves. The valves are mounted on insulators fitted on the back of the slate panel on which the instruments for this stage are mounted.

The 50-kW stage utilises three water-cooled valves, similar to those in the power units, and the manner of mounting, &c., is similar to that of the power units.

The coils forming the inductances of the high-frequency circuits of both stages are constructed of cable of insulated and stranded wires, the cable being wound on a framework of American whitewood in a similar manner to that adopted for the large tuning inductances described later. The cable of the 4-kW stage inductance is 243/36 S.W.G. and that of the 50-kW stage is 729/36 S.W.G. The condensers of these high-frequency circuits are mica condensers in oil.

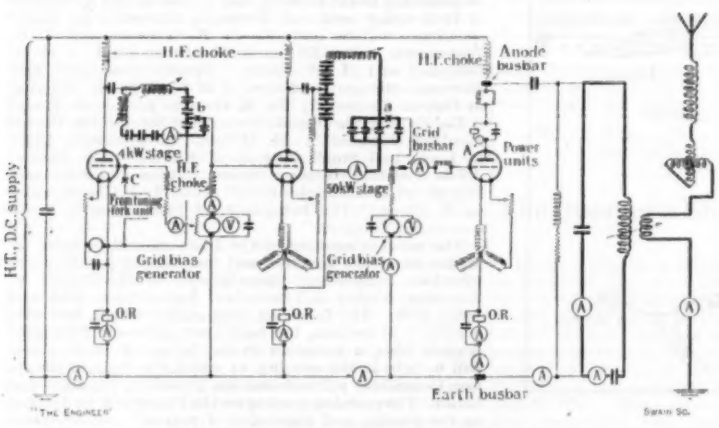


FIG. 3—DIAGRAM OF TRANSMITTING CIRCUITS

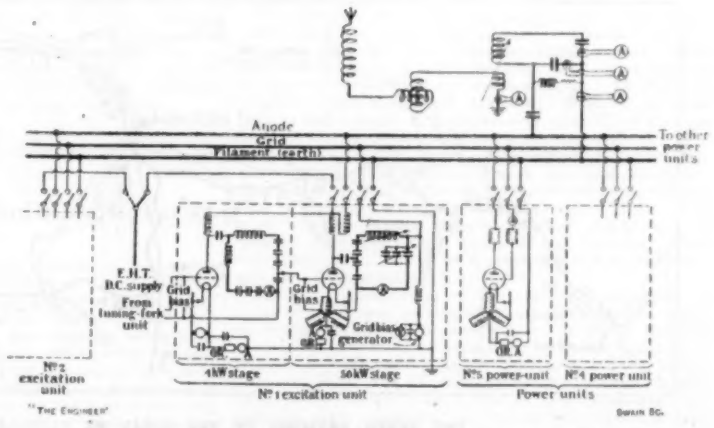


FIG. 4—DIAGRAM SHOWING ARRANGEMENT OF BUS-BARS

The safety devices, relays, &c., are similar to those used in connection with the power units.

Associated with each excitation unit is an auxiliary machine unit consisting of one motor driving four generators. These generators have the following ratings, and are utilised for the following purposes :—

(1) 500–1500 volts ½ ampère. Anode supply for various amplification stages of tuning-fork unit.

(2) 15–20 volts, 60 ampères. Filament supply for 4-kW stage, and also for tuning-fork unit by means of potentiometer.

(3) 40–600 volts, 12 ampères. Grid-bias voltage for power units.

(4) 200–600 volts, 1·5 ampères. Grid-bias voltage for 50-kW stage and also for 4-kW stage by means of potentiometer.

The motor driving this unit has a remote controlled

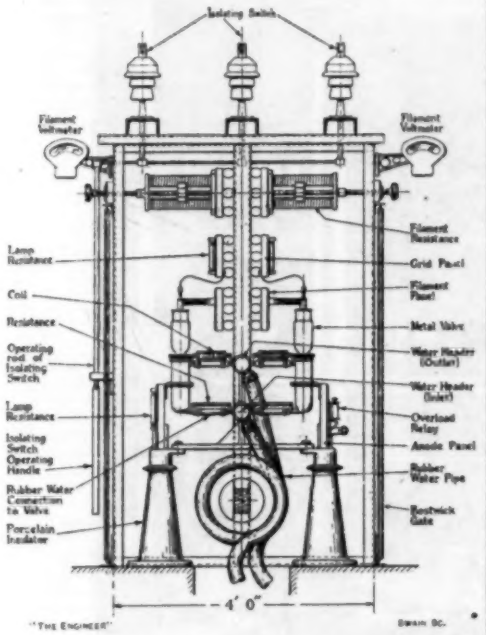


FIG. 5—SECTION OF POWER UNIT

starter, so that all the various auxiliary powers required are obtained by the pressing of one button at the control table.

With such a chain of amplifiers as that forming this installation, one probable difficulty to be combated is the self-oscillation of the system in whole or part due to the retro-action from the later to the earlier stages, but this tendency to self-oscillation can be reduced by very careful screening between the various stages. The tuning-fork unit is made up in the form of two copper boxes with copper partitions between the different stages and tight-fitting copper lids to the various compartments. The excitation units and tuning-fork units are placed inside a screened enclosure, the sides and top of which are formed of copper mesh—fourteen to the inch—mounted on a suitable framework. Internal partitions of similar copper mesh complete the screening between the tuning-fork unit, the 4-kW stage and the 50-kW stage respectively.

THE POWER UNIT.

The power unit, consisting of eighteen valves, is a rectangular enclosure arranged with nine valves on each side and a front slate panel containing the meters.

The three bus-bars run above the various power units and the excitation units and each power unit can be connected to the bus-bars by a three-pole switch. The three-pole switch for connecting a power unit to these bus-bars cannot be operated until the Bostwick gates on the sides of the unit have been closed and locked, and the keys locked in the switch itself; the converse holds that the gates of the unit cannot be opened until the keys for opening them have been released by the opening of the switch, which "earths" all parts of the power unit. These interlocking devices render the operation of the power units quite safe.

The front panel of a power unit carries the following instruments :—An ammeter reading high-frequency feed current from the power unit into the oscillating circuit; an ammeter reading anode direct-current feed current to power unit from high-tension machines; an ammeter reading mean direct-current grid current of power unit; a recording ammeter of filament current, by means of which the actual running time of unit and the life of individual valves can be obtained; an overload relay for the complete power unit which trips the main high-tension direct-current switch; an "Electroflo" meter, which reads the actual total rate of flow of water through the valve jackets of the unit; and a relay in association with the "Electroflo" meter which operates if the flow of water falls below a certain amount, and trips the main high-tension direct-current switch.

Fig. 5 is a section through a power unit parallel to the front, showing the juxtaposition of the various panels. Slate panels have been used in all cases for mounting the various apparatus and fittings, these slate panels being supported and insulated from the earthed iron framework by suitable porcelain insulators.

The two anode panels are supported from the floor by four 18in. insulators. These insulators also support the copper water pipes between these panels which not only act as headers for the water supply to the anodes, but also as the anode bus-bars for the valves in the panel.

The anode panels carry the valves in their water jackets and the overload relays in the individual anode circuits. In the event of any particular valve taking an excess current due to softness or any other reason, the corresponding relay operates, releasing a hammer normally held up by the armature of the relay which, in turn, operates a mechanism which trips the high-tension direct-current switch by breaking the "holding coil" circuit. The arrangement has proved to be very effective, and oscillograms which have been taken show that the high-tension switch is broken in about a quarter of a second following an excess of current through the relay.

The water system used for cooling the anodes is a closed system using distilled water, which flows by gravity through the valves. The water is pumped from the bottom tank back to the upper supply tank through a "water cooler" where the heat is extracted by an independent circulating water system.

The distilled water is supplied to the anodes of the power unit through 30ft. of 2in. diameter rubber hose wound on a horizontal wooden drum at the bottom of the power units. This rubber hose feeds the 3in. copper header which passes down through the centre of the unit and which, in turn, feeds the individual valves on each side through short lengths of rubber tubing to the lower ends of the valve jackets. The oulet water from the upper ends of the valve jackets passes to a similar header, which discharges through another length of 2in. hose similar to that used for the inlet water and wrapped round the same drum. The long length of water in the rubber hose provides the necessary insulation of the anodes from the earthed metal parts of the water-cooling system, and the drum carrying this hose is a part of the insulated anode system. The short lengths of rubber tube from the headers to the valves provide the insulation required between valves to permit the insertion of relays, coils, &c., in the individual valve anode circuits. The porcelain floor insulators and the large rubber hose are shown in Fig. 5.

The insulation of the anode system of one power unit under working conditions, with water flowing, is of the order of 520,000 ohms, giving a leakage current through the water at 10,000 volts of only 20 mA.

Immediately above the anode panels are the filament panels, which carry the filament bus-bars for the unit and the flexible braided leads from these bus-bars to the separate valve filaments. Above the filament panels are the grid panels, which carry the grid bus-bar—in the form of a complete loop of copper strip between the panels—and also any "stopper" circuits referred to later.

Above the grid panels are the filament rheostats, one of which is provided for each valve, together with a voltmeter key to enable the actual filament voltage to be read by means of a swinging voltmeter at the end of the panel. This independent variation of the filament voltage in order to obtain the rated value for each valve is very necessary in order to conserve the life of the valves, the life being seriously shortened if the filament is run continuously slightly above its rated voltage.

THE PARALLELING OF VALVES IN A UNIT.

One of the difficulties in designing a large power transmitter using a large number of valves is the tendency of such valves to "self-oscillate," individually or in groups, the inter-electrode capacity of adjoining valves or groups of valves forming the condenser of the oscillating circuit in association with the inductance of the connecting leads, &c. These difficulties are increased with water-cooled valves where the existence of the water jacket increases the inter-valve and inter-electrode capacities very considerably. Every such difficulty of this nature must be examined and dealt with separately.

The arrangements used successfully at Rugby are :—Two small condensers of 400 $\mu\mu$F each are mounted on each valve between the grid and each end of the filament, and a series non-inductive resistance of 100 ohms between each individual grid and the grid bus-bar. The anode feed from the individual valves to the top water header—which acts as the anode bus-bar—consists of an inductance of 50 μH in parallel with a non-inductive resistance of 60 ohms to the same header and a similar non-inductive resistance to the bottom water header, these two headers being metallically connected at the end of the panel.

Fig. 6 gives the circuit arrangements of a complete power unit.

THE PARALLELING OF POWER UNITS.

The paralleling of the power units themselves also involves consideration as to the method of prevention of inter-oscillation between power units.

At Rugby the combined anode of the power unit is fed to the main anode bus-bar through a "stopper" circuit consisting of an inductance of 100 μH in parallel with a resistance of morganite plates of 8·5 ohms. The combined grid of the power unit is fed to the main grid bus-bar through a "stopper" circuit, consisting of an inductance of 50 μH in parallel with a resistance of 300 ohms formed by six straight-filament lamps in series. Their positions in the circuit are shown in Fig. 6

These "stopper" circuits are fitted at the back of the power unit in the space above the filament transformer and immediately below the three-pole power unit isolating switch, to two terminals of one side of which they are connected.

After dealing with safety devices and the control circuit, the author considers the electrical proportions of a coupled aerial circuit.

Any large power valve transmitter should be provided with a coupled circuit, since the use of a valve transmitter at reasonably high efficiencies necessitates the production of a certain proportion of harmonics which should be filtered from the aerial.

As regards the emission of harmonics, the improvement obtained by using a coupled circuit of the type used at Rugby, instead of a plain aerial circuit, is dependent, among other factors, upon the product of the decrements of the primary and aerial circuits. When a low-decrement aerial tuning inductance is provided the decrement of the aerial circuit at a given frequency is practically fixed, being mainly dependent upon the external part of the circuit.

It is therefore important that the decrement of the primary circuit be made low, and this involves the provision of the most efficient inductance coil and condensers having very low loss. The cost of the primary circuit is roughly proportional to the kVA with which it has to deal, except at the higher voltages, where the cost increases rather more rapidly than the kVA.

The efficiency of the coupled circuit and the improvement as regards harmonic emission obtained by using the coupled circuit are both independent of the ratio of inductance to capacity in the primary circuit. Under these circumstances, the actual value of the inductance was chosen from a consideration of the following :—The cost of the coil decreases slightly as its inductance is decreased; above a certain working voltage the cost of the condenser increases at a more rapid rate than its capacity; the cost and difficulty of insulating leads are increased when high working voltages are increased.

This led to the decision to have a primary circuit inductance of the low value of 500 μH. The values of the con-

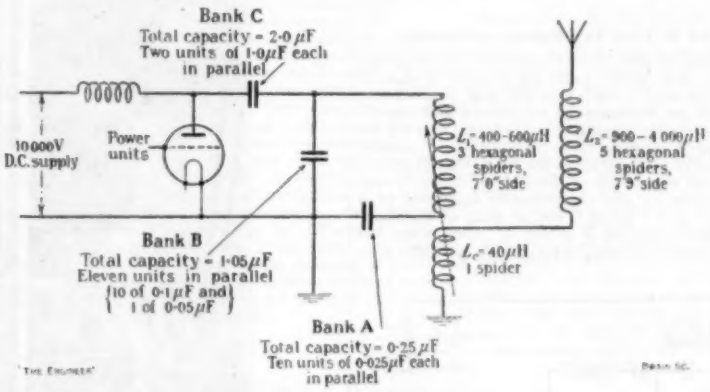


FIG. 7—COUPLED AERIAL CIRCUIT

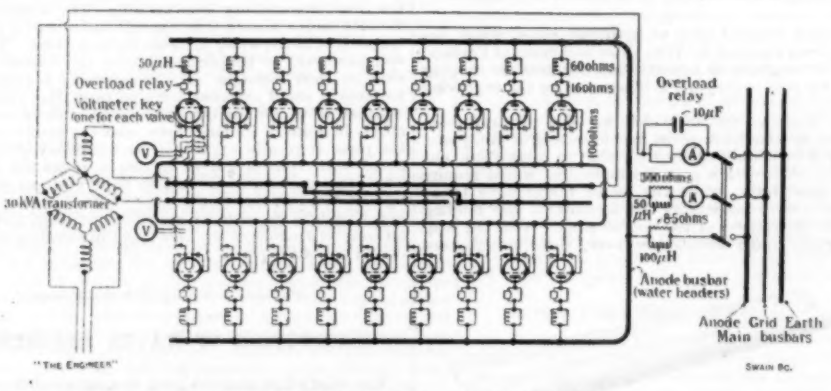


FIG. 6—WIRING DIAGRAM OF POWER UNIT

densers making up the primary oscillating circuit are given in Fig. 7. The condensers used are mica condensers immersed in oil, made by Messrs. Dubilier to meet the Post Office specification. These have a power factor of 0·00025 at the working frequency.

The aerial coil consists of five spiders, each of eight turns, wound in the form of a hexagon, with 7ft. 9in. external side—5ft. 9in. mean side. The distance between individual turns is 6in., and the inductance is continuously variable between 900 and 4000 μ H.

The primary circuit coil consists of three spiders, each of four turns, wound in the form of a hexagon with 7ft. external side—6ft. 2in. mean side. The distance between turns is 6in., and the inductance continuously variable from 400 to 600 μ H.

The coupling coil has a single spider, wound with two turns, 6ft. 5in. external side. This coil is mounted on the same framework as the intermediate circuit coil, and is coupled thereto. The inductance has a value of 40 μ H.

One outside spider can be moved by a screw in order to get a fine adjustment of tuning. The method of making a joint in the stranded wire between the spiders is to splay out the strands on a number of insulated flat copper plates and semi-conical copper fittings, so as to ensure proper circulation of current through all the strands and to keep a cool joint.

Method of Keying and Shape of Signals.

One of the greatest difficulties experienced in the design of any type of large power radio transmitter is that of successful keying, and in each case the best method and best adjustment are obtained by experience and experiment. A considerable amount of experimental work on various methods of keying a valve transmitter was carried out with the 50-kW transmitter at the Post Office Northolt radio station, and as a result of those experiments, it was decided to provide for the simultaneous operation of a simple "make" and "break" key at each of the three points in the circuit marked X in Fig. 3. The system has proved to be eminently satisfactory, and no difficulties

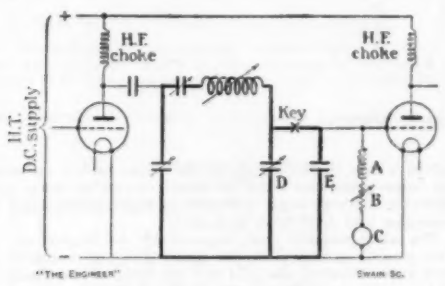


FIG. 8—INTER-STAGE CIRCUIT

have been experienced up to the highest powers used at present. Creed pneumatic keys are used for points *a* and *b* and a magnetic relay for point *c*.

It will be observed that there is no oscillation in the aerial when the key is "up," and that this result is obtained by breaking the feed to the grid from one stage of amplification to the next—as shown in Fig. 8—which is a skeleton diagram of the last inter-stage circuit.

There are two points of particular interest in the arrangement. The first is that the key splits the coupling condenser to the grid and leaves the condenser E between the grid and filament when the key is up. This condenser is of sufficient value to make the impedance from grid to filament capacitative, and this counteracts any tendency that this stage may have to self-oscillate.

The second point of interest is the series circuit A B C from grid to filament. A is merely a high-frequency choke, B is an adjustable resistance—grid leak—and C is a direct-current—grid bias—generator. When the key is down, the mean negative grid potential is the sum of that due to the grid leak and the generator; when the key is up, the only bias is that due to the generator. By adjusting the proportions of the bias due to grid leak and generator respectively when oscillating, it can be arranged that the generator voltage is sufficient to allow a suitable direct-current current to pass through the valves when the key is up. The advantages of this are two-fold, as follows:—The direct-current load with "key up" reduces the voltage "kick" on the generator with keying; and the conductive path through the valve—due to the small grid bias—increases the damping of the aerial when the key is "up" with a corresponding improvement in the shape of the signals.

TIME TAKEN TO START A STAND-BY POWER PLANT.

Recently a test was made to ascertain how long it would take to put into operation the steam standby plant, which works in conjunction with the Winnipeg Hydro-electric Power Station. The following particulars of the trial have been taken from the columns of a Canadian contemporary.

It appears that, without warning to any member of the standby crew other than the superintendent of the steam station, the main power switch bringing current to feed the stand plant waterworks and light and power services was "tripped" at 10.25 o'clock, with the result that the plant ceased to operate. At the sound of the siren which announced the fact that power was cut off, storage steam, which is held in readiness to drive the 1000 horse-power house turbine, was admitted to the machine by the staff, and in two minutes the turbine began to revolve. In 2½ minutes there was sufficient electrical energy being developed to start feeding the coal into the steam boilers again, and that power was then directed to "warming up" the two 7500 horse-power turbines, which are held in readiness for emergency standby use. At 10.48, that is to say twenty-three minutes after the current failed, the first turbine was "turning over" and three minutes later the second machine was in operation.

Though not the first test to which the standby plant has been subjected, it was one of the most successful which has been tried, and it proved beyond a doubt that the whole plant is capable when called upon, to replace the electrical power supply from Pointe du Bois. It is interesting to note that the three turbines mentioned were supplied by James Howden and Co., Ltd., of Glasgow.

A DOUBLE-ACTION HYDRAULIC PRESS.

A rather unusual form of hydraulic press, which has recently been supplied by Wm. Grice and Sons, of Fazeley-street, Birmingham, to a North Country firm for shaping troughs for coal conveyors, is illustrated by the engraving above.

These troughs—one of which we also illustrate—are 12ft. long by about 3ft. wide, and are made of ¼in. plate, and it will be readily understood that to press them out of the flat cold, with a pair of simple dies, would require a very great force, while the metal would have to be stretched very considerably on account of the binding action on the corners of the double step. With the help of the press under review, however, these troughs are

TROUGH FOR COAL CONVEYOR

produced without stretching the plate at all, and with the expenditure of a force of only 450 tons.

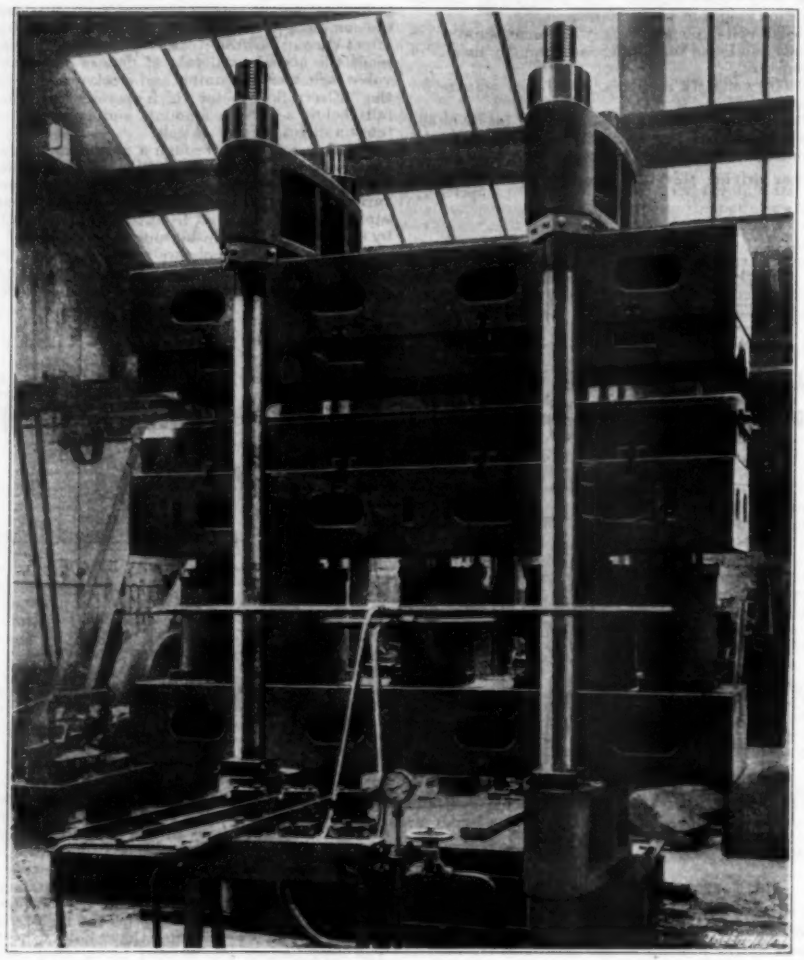
On reference to the engraving it will be seen that the female shaping die is fixed to the upper platen of the press, which is stationary. The whole machine, by the way, is set in a pit, so that the dies come about the floor level. Below the lower table there are five hydraulic rams. The second and fourth of these rams are larger than the other three, and are connected directly with the table, while the other three are extended upwards through appropriate holes in the table. There is, of course, a lower yoke to support the thrust of the rams, and the whole combination is tied together by massive columns.

The provision of the double set of rams enables the troughs to be produced by an action which more resembles bending than pressing, in the following manner. The three smaller rams are used to work the central part of a split male die and press the plate into the deep recess of the opposite die. The water pressure is kept on these rams, to hold the plate securely, and the table is then brought up by the two large rams. The table carries the two outside pieces of the male die and folds the plate into the shallower step of the trough without any binding action on the corners. The two parts of the die are then brought down together and the plate, which is registered in position in the dies by means of pegs and the rivet holes shown, is prised out of the press.

A noteworthy feature about this machine is the employment of a special form of control valve, also made by Messrs. Grice, which provides a very free exhaust passage. There are two separate conical-seated valves, one for the inlet and the other for exhaust, arranged on one centre line and operated by one spindle. The exhaust valve is much larger in area than the admission valve, and they are subject to the water pressure on both faces. The areas are, however, so proportioned that the valves tend to close on their seatings. The consequence is that it only requires a small external force to open the valves; the exhaust valve can be quickly opened without any great effort, in spite of its large area, and the return stroke of the press is greatly expedited, as compared with presses fitted with control valves having a restricted exhaust. The press under review can, in fact, perform three full up and down strokes in a minute; but in making the conveyor troughs its output is restricted to about forty pieces an hour on account of the time spent in handling the plates in and out of the press.

PRESS FOR SHAPING CONVEYOR TROUGHS

WILLIAM GRICE AND SONS, BIRMINGHAM, ENGINEERS



INSTITUTION OF WATER ENGINEERS.

The thirty-first summer general meeting of the Institution of Water Engineers will be held in Manchester and the Lake District, on Wednesday, Thursday, Friday and Saturday, June 9th to 12th inclusive. By permission of the Lord Mayor and Corporation of Manchester, the meetings will be held in the Council Chamber, Town Hall, Manchester.

The following programme has been arranged:—On Wednesday, June 9th, at 10 a.m., an official welcome on behalf of the City of Manchester will be extended to the Institution by the Lord Mayor of Manchester, Councillor Miles E. Mitchell, and the Chairman of the Waterworks Committee, Sir Edward Holt, Bart. The chair will be taken by the retiring president, Mr. A. E. Cornewall-Walker, M. Inst. C.E. The programme of business will include the presentation of premiums awarded by the Council for papers read during the past year; the installation of the president-elect, Mr. Lewis Holme Lewis, M. Inst. C.E., M.I. Mech. E., water engineer to the Manchester Corporation, and the reading of his presidential address; also the discussion on papers. In the afternoon the members will be taken by motor coach to the Whitworth-street West Pumping Station, after which Lostock Booster Station and Heaton Park Service Reservoir will be visited. In the evening, at 7 p.m., the thirty-first annual dinner

of the Institution will be held at the Midland Hotel, Manchester.

On the Thursday, at 10 a.m., the meeting will be resumed in the Council Chamber at the Town Hall, Manchester, for the continuation of discussion on papers. In the afternoon, at 2.15 p.m., motor coaches will leave the Town Hall, Manchester, for the Prince of Wales' Hotel, Grasmere, and will travel *vid* Bolton, Preston, Lancaster, Carnforth, Kendal, Windermere and Ambleside. In the evening, at 8 o'clock, there will be an informal dinner at the Prince of Wales' Hotel, Grasmere.

On the Friday, at 9.30 a.m., motor coaches will leave the Prince of Wales' Hotel for Thirlmere and its waterworks, after inspecting which the party will proceed to Penrith, where luncheon will be taken at the George Hotel at the invitation of the President. In the afternoon the members will proceed to Haweswater and Mardale, travelling *vid* Shap and Bampton, and will return in the evening to Grasmere by way of Ullswater and the Kirkstone Pass. On Saturday, June 12th, the party will return to Manchester by motor coach.

The following papers and communications will be considered at the meetings:—"Manchester Waterworks," by W. F. H. Creber, M. Inst. C.E.; "Water Supply Finance," by A. W. Kenyon; and "Some Metallurgical Problems of the Waterworks Engineer," by W. E. W. Millington, M. Inst. C.E., M.I. Mech. E.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

THE spring quarterly meeting of the Midland Iron Trade was held in Birmingham to-day—Thursday—when there was a large and representative gathering, but it must be confessed it resulted in little additional business finding its way to producers' order books. The outlook from the labour standpoint is so black and the future of trade so impossible to foresee, that as contracts expire consumers are with one consent resorting to small-scale purchases, which enable them to carry on from week to week. There was little or no expectation that the new quarter will add very materially to the volume of business. The iron and steel trades have been almost killed by the coal imbroglio, now approaching the decisive phase, and until a settlement is reached, business will not go forward. Dependent industries look for a settlement of this long drawn-out contention that will give them a stable basis for development. Under the shadow of labour conflicts the basic industries in the Midlands and Staffordshire have made no progress during the past quarter. It has been impossible for contractors to make plans for the future while the issue remains unsettled. Yet apart from the uncertainty due to the coal and engineering clouds, the prospects for Midland industries during the second quarter are considered to be satisfactory, and it is held that with a clear field there would be an excellent chance of a rebound of trade. Local rolling-stock builders have good order books, though much of the business has been taken, it is said, at prices which can scarcely be called remunerative. Constructional engineers are regularly employed on small contracts though they have much difficulty in convincing their customers that there is no advantage to be expected from delaying projects. Mechanical and electrical engineers are well placed and anticipate a steady flow of contracts from the various power station extension schemes now under consideration. In some departments of the latter branch, enterprise is retarded by the controversial issues involved in the unification scheme. Machine tool makers report that the majority of orders coming along are for almost immediate delivery. Usually one is able to gather from the quarterly meeting what is likely to be the course of events over the next three months in the iron and steel industries, but little was to be gathered from to-day's gathering. Everything depends upon peace in the labour world, and this everyone on 'Change in Birmingham to-day earnestly desires.

Raw Iron.

There was little new business in pig iron forthcoming at to-day's meeting, and those smelters who had hoped to find consumers taking the usual course of covering their requirements for the next quarter were disappointed. Buying, such as it was, was confined to small lots for immediate use, and the market in this branch was left almost entirely in the dormant condition which has prevailed now for fully two months. Brisk buying at the opening of the year was followed very soon by a relapse, and the market gradually sank into a stagnant condition such as has not been often paralleled. Smelters who had stiffened their prices when demand promised well in January hung on doggedly to their quotations in spite of the drying up of the market. Most of them were well sold, and they tried to believe that buying would be renewed when contracts ran out. This did not, however, prove to be the case, and in March there was a definite fall in values, leaving them, if anything, slightly below those which ruled when the quarter opened. There were those who expected a further fall at to-day's meeting, and they expressed surprise, with demand so sluggish, that makers should uphold recent quotations. For Northamptonshire forge, £2 15s. to £2 16s. was asked; while for No. 3 foundry makers wanted £3 3s. to £3 4s. Derbyshire smelters quoted forge £3 upwards and foundry £3 6s. to £3 6s. 6d. There were Derbyshire makers who would not entertain anything below £3 7s. 6d. for foundry grades, but buyers were not prepared to concede to these terms when adequate supplies could be obtained at 1s. per ton less. Most of the pig iron which is being produced in the Midlands appears to be going into consumption, and little stocking is taking place.

Industrial Fuel.

In spite of the clouded outlook in the coalfields, industrial fuel prices remain only moderately firm, and manufacturers experience no difficulty in securing supplies. At the opening of the January quarter producers of furnace coke thought they discerned elements of strength in the market which would enable them to obtain more remunerative rates for supplies to the blast-furnaces. Prices were forced up, with the result that the expansion of business was retarded. The enhanced price of coke could not be maintained, and blast-furnaces are now able to supply all their wants at a price something like 6d. per ton less than the figure which ruled when the quarter opened. The rate at which fuel has been absorbed in recent weeks suggests that manufacturers are insuring against a possible stoppage more systematically than has been supposed. It remains true, however, that in the heavy branches many industrialists have been carrying on during the past two months in face of such discouragements that they are determined to close down at once should their troubles be aggravated by a rupture in the coalfields.

Finished Iron.

There is no improvement in the Staffordshire finished iron trade. Mills are working intermittently, especially those engaged on Crown and nut and bolt quality irons. Were it not for the re-rolling of steel, which many Staffordshire ironmasters have taken up increasingly during the last six months, most of the Staffordshire works would be idle. There is, of course, still a reasonable demand for high-class Staffordshire bars, and at the quarterly meeting to-day many Midland engineers were able to place contracts which, though individually small, amounted in the aggregate to a fairly large tonnage. The basis rate of marked bars remains unaltered at £14, at which figure it has stood during the past quarter. Internal competition in the common bar branch is not so acute, Lancashire makers not cultivating business in this district as thoroughly as they were doing two months ago. Nevertheless the standard quotation of £11 10s. is rarely obtained. Business was done to-day at round about £11 2s. 6d. Nut and bolt bars are in small request, for even at £10 5s. they are pounds dearer than continental material used in many of the Darlaston nut and bolt works. Tube makers in this district are better employed, and are calling for fair quantities of strip, paying £12 5s. to £12 10s. per ton.

Position of Steel.

In the steel department there was a fairly good inquiry, but there can be no doubt that there is a general suspension of big undertakings, engineers, municipalities, and others preferring to wait for stable conditions before giving out costly business. The arrangement for stabilising home prices of structural steel released a certain amount of new business, but there were few indications of any development in this district. Midland steel works succeeded in maintaining the prices lately fixed by the Association, and their success, in this respect, was taken as an indication of a fairly strong market. Angles and joists changed hands at £7, joists at £8, ship, bridge and tank plates at £7 15s., and boiler plates at £11. In other departments of the steel market, however, quotations were subject to a fair amount of variation. Small rolled bars ranged in value from £7 15s. to £8, while Staffordshire hoops made from £10 5s. to £10 10s. at works. The great activity of building is absorbing a substantial aggregate of miscellaneous steel. Foreign competition is chiefly under the head of finished material, the semi-finished steel, which has been imported very heavily during the past twelve months, being now scarcely obtainable. British mild steel billets are accordingly a little firmer at £6 per ton. Large South Wales firms were stated to be prepared to shade this figure for large tonnages, but little advantage appeared to be taken of this, consumers in the Midlands preferring to keep their tonnage down to a limit somewhere in the neighbourhood of immediate consumptive requirements. They do not want, in the event of a closing down of works, as a result of labour upheaval, to have large quantities of billets in stock. The amount of business forthcoming from the quarterly meeting was, to steel makers, disappointing.

Galvanised Sheet Prices Weaken.

A lull in the buying of galvanised sheets, although not sufficient to check production, has weakened prices. At to-day's quarterly meeting quotations varied widely. Some mills that cater for home requirements named £16 5s. for 24-gauge corrugateds. The quotation denotes that they have good order books. It is well above the market level, however, and many mills less fortunately placed asked as low as £16. Larger interest centres in the export trade, and for big scale business millowners, whose forward position is insecure, quoted £15 12s. 6d., and orders were said to have been taken at £15 10s.

Cannock Chase Miners' Wages.

The wages for April for the miners of Cannock Chase have been fixed by the Area Wages Board at 46·6 per cent. over the basis, which is the same as for the past eight months. This fixes a stallman's minimum wage at 9s. 8d. per shift.

Railway Contract for Birmingham.

The Metropolitan Carriage, Wagon, and Finance Company of Birmingham, has been awarded a contract for 100 bogie brake vans for the Buenos Aires Great Southern Railway Company.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE condition of the Lancashire iron and steel markets since the resumption of operations after the Easter holidays has been unsatisfactory. At the risk of repeating what has been said here before, the point cannot be too strongly emphasised that all sections of the markets are becoming more and more influenced by the troubles which threaten the coal and engineering industries. The position now seems to be, from the point of view of the consumers of the products of the iron and steel industries, that as they have held off the market so long, there can be no harm in holding off until the outlook becomes less obscure, and the result is that transactions for the most part are of a desultory character. On the other hand, one frequently comes in contact with people on 'Change here who hold the view that even a settlement of the troubles will not bring out much fresh buying, their argument being that the volume of business that has been experienced during, say, the last six weeks, really represents the state of the consuming industries. The correctness of this ultra-pessimistic view is, however, extremely improbable, although it must be admitted that the position of the engineering industries in this district is, speaking generally, far from favourable. A conference of the engineering trades unions and the Manchester District Employers' Association was held on Monday of this week to consider the application of the men for an increase of £1 a week. This was refused, and the application was referred to the Central Conference.

Non-ferrous Metals.

The position of the non-ferrous metals market is distinctly unsettled. When I reviewed the position last week there was a steadier tone in all sections after a week of marked weakness. Almost immediately after writing there was a further relapse, tin, in particular, suffering a severe fall last Friday. This has been followed this week by a fresh recovery—and so it goes on. Cautious buying by users as a result of the general uncertainty is, of course, a bearish influence, but the unsettled state of the market itself does not tend to increase buying confidence. Add to this, the easier tone in the American markets and there are sufficient weakening influences to affect the market. This applies both to tin and copper in particular. Lead has also lost a good deal of ground, and at one time was as low as it had been at any period during the last eighteen months. Spelter was affected, although less seriously. At the moment, the position in all sections is better than it was at the worst point during the past week, but it is by no means steady, and, so far as this centre is concerned, the demand for none of the metals is very pressing just now.

Iron.

In the iron market there has been little apparent change in the situation, and both buyers and sellers seem to be marking time. A good many users are, of course, covered under existing contracts entered into several months ago, and there are comparatively few fresh commitments being entered into at the moment, current business still being of a hand-to-mouth nature. Whilst there is scarcely sufficient business passing to furnish a real test of prices, there is perhaps a slightly easier tone in some sections, although the level of values has not perceptibly altered. For Derbyshire No. 3 foundry pig, quotations range from 75s. to 75s. 6d. per ton, delivered Manchester or equal distance, with Lincolnshire and Staffordshire both on offer at about 76s. per ton, Scottish No. 3 at about 94s., and West Coast hematite at from 93s. to 94s. Forge iron is still a very dull market, and little demand for this material has been reported. Lincolnshire and Derbyshire makes are quoted at from 72s. 6d. to 73s. 3d. per ton delivered here. Towards the end of last week Lancashire bar iron makers announced an important reduction in prices, Crown bars now being quoted at £11 per ton as compared with £11 10s. previously, and second quality bars at £9 15s. against £10 5s., prices which include delivery into this area. Makers of bars are having a serious time, faced as they are with the competition of steel and the low prices quoted by continental makers.

Steel.

The steel market has been uniformly quiet since the resumption last week, and there appears to be very few inquiries of any substance circulating here. Beyond filling early needs, users are buying little. Sellers are adhering very firmly to the controlled prices, and there is a feeling in certain quarters that an advance on these may take place before long. If this comes about it may result in more active forward buying. In the meantime, joists and section material range from £7 to £7 2s. 6d. per ton delivered Manchester or equal, plates at £7 15s., and steel bars at £7 17s. 6d. to £8 5s. per ton. Apart from a few parcels booked for South American markets, the demand for galvanised sheets since last report has been quiet, very little having been on account of India. From £15 10s. to £15 12s. 6d. per ton f.o.b. is the range of values for the usual Indian specifications, but it is possible at the moment to buy at something below these figures in the case of a decent order. Sellers of continental material are booking comparatively little business just now. Values seem still to be weak in virtually every section. Ordinary billets are at £5 2s. 6d. to £5 5s. per ton, delivered Manchester or equal, for net cash against documents, while Siemens plates are at about £6 12s. 6d., ordinary plates at £6 7s. 6d., steel bars at £6 2s. 6d., sheet bars at £5 5s., and joists at £5 16s.

Scrap.

There is little movement in iron and steel and non-ferrous metal scrap, and quotations are easy pretty well all round. Mild steel is about 52s. 6d., wrought iron at 65s., textile machinery scrap at 70s., and ordinary machinery cast iron scrap at 65s., on rails, Manchester. Among the non-ferrous metal scrap, for graded materials and including delivery to users' works, cast aluminium is £88, zinc £24, lead £29, braziery copper £49, heavy copper £81, heavy yellow brass £45, and best selected gunmetal £52 to £53 per ton.

New Uses for Old Gas Engines.

Many of my readers who have seen the three 1500-kilowatt Nürnberg gas engines and generators at the Castner Kellner Alkali Company's works at Runcorn, will be interested to learn that these engines are about to be

removed. Galloways, Ltd., Manchester, have received instructions to dismantle them, load them on to rail and re-erect two of the engines as blowing engines at the works of the Appleby Iron Company, Scunthorpe. This work will necessitate the provision of new blowing cylinders. The third engine with its generator is to be re-erected at the Frodingham Iron and Steel Company's works. Messrs. Galloway have also received an order from the Avondale Tin-plate Company for a uniflow engine with a cylinder 40in. diameter by 3ft. 6in. stroke. This engine will make 107 revolutions per minute, and will drive six tin-plate mills at 28 revolutions per minute, through machine-cut gearing.

Where Trade is Better.

The directors' report of Beyer, Peacock and Co., Ltd., the well-known Manchester locomotive builders, furnishes a pleasing example of a revival in the fortunes of a firm which for some time had suffered from the prevailing slump in the engineering industry. The accounts show a trading profit for the year of £36,423, which is reduced to a net profit of £9547 by the deduction of £7787 for interest on the debenture stock and £16,242 placed to the depreciation reserve. This result compares most favourably with the two preceding years. In 1924, for instance, there was a net loss of £42,508, while in 1923 the net loss was even more, actually £87,000. Besides paying the debenture interest and the dividends due upon the 5½ per cent. cumulative preference shares for the half years ended December, 1924, and June, 1925, the directors are carrying forward a sum of over £17,000, and are looking with confidence to a still more prosperous time in 1926, provided no serious labour troubles arise, for there is sufficient work on hand to keep the works well employed until well on to the end of this year. Under the guidance of the general manager, Mr. Robert H. Whitelegg, I had an opportunity of inspecting the works one day recently, and was much impressed by both the alterations and by the improvements which have been and are still being effected in the plant and buildings at Gorton. The addition of the new boiler shop—one of the finest in the country—the plant for which is now approaching completion, will prove a great boon to the company. Amongst the work which I saw in progress, the Ljungstrom turbine locomotive is now rapidly approaching completion. Although based on continental practice, this locomotive will embrace some original features. There are also in course of construction five electric freight locomotives for harbour work at Montreal, four large Garratt locomotives for Uganda, and twenty eight-wheels coupled compound locomotives for the Central Argentine Railway. I also noted three Garratt locomotives for the Sierra Leone Railways and a larger engine of similar type, all of which are ready for shipment. Besides the orders above mentioned, Beyer, Peacock and Co., Ltd., has now on hand a considerable amount of boiler work, and altogether the outlook for the firm is very promising.

Barrow-in-Furness.

Hematite.

The condition of the hematite pig iron trade in the north-west district is quiet. There is no heavy volume of trade in any direction, and many customers are either requiring little tonnage or they are marking time until the horizon is somewhat clearer. Most of the buyers are taking small parcels, and it would appear that they are simply living from hand to mouth, as it were, at present as far as supplies are concerned. What weakens the market from a trade point of view is the fact that very few buyers are ordering for forward delivery, and for that condition of affairs one can with confidence put the blame to the threatened coal trouble, and the feeling of unrest among the engineers. The Midlands are taking the most iron, and Scotch business is weak. The amount of trade with Wales is poor, and the continental business is negligible. The fall of the franc operates against local iron being sold abroad. American business is still being done, but it comes in fits and starts, and is mostly for semi-special qualities. A certain amount of iron has gone into stock, owing to the steel departments having been stopped, but at Barrow a fair amount of iron is again needed.

Iron Ore.

The general state of the iron ore trade is that of sluggishness. With the small number of furnaces in blast in the district, speaking comparatively, coupled with the fact that little is being sold outside, the demand is small, and few mines are what one might call active. Some are practically idle. The amount of business in foreign ore is restricted, and the number of cargoes arriving is not big.

Steel.

The steel trade is quiet, and although the Barrow rail mills are again employed, not many orders are held, and more are needed to keep the mills going. At Workington there are not sufficient orders to keep the mills going regularly. In the hoops and small sections departments at Barrow there is a better state of things. The foundry and Siemens departments at Barrow are at work.

SHEFFIELD.

(From our own Correspondent.)

Increased Output of Steel.

There is a better tone in the heavy steel trade, especially in the open-hearth section. During the last few months there has been a steady increase in the output of steel in the district, and in February the total reached more than 100,000 tons, which was the highest for at least two years. The open-hearth department was chiefly responsible for the improvement. Its output in February was larger than in either January of this year or February of last. The various plants are still working in excess of last year's average, with the exception of that at Stocksbridge, where conditions are quiet. There is not the same advance to be reported in Lincolnshire, where the figures of production have remained with little alteration for a considerable time, but the output of pig iron is increasing there. The improvement in trade might be more rapid, but for the unsettled condition of the coal industry, which is adversely affecting buying and selling, and is leading traders to act with extreme caution. There is no improvement in the scrap market, which has shown scarcely any change all this year. For heavy basic steel, buyers offer only 63s. 6d., but holders demand at least 65s. for immediate delivery and more for forward contracts.

Railway Work.

The railway steel departments, which produce axles, tires, springs and buffers, are still among the busiest on the heavy side of the steel trade, and are well supplied with work for the home companies. There is, however, still a great shortage of orders from abroad, especially from India and South America, and this has a serious effect on the remunerativeness of the work. Prices keep low. The importance of the export trade was emphasised by Mr. G. E. Baker, the chairman of John Baker and Co., Ltd., of Rotherham, at the annual meeting of the company last week. He said that the Indian market used to be their principal one, but along with the rest of the export trade it had almost disappeared. In 1913 they exported 66 per cent. of their total output; in 1920 the tonnage was about the same, but was only about 42 per cent. of the output; while in 1925 the value of the export trade was only about half that of 1913, and represented only 19·3 per cent. of the total output. Although prices in 1925 were less than half those of 1920, the aggregate amount of business was 30 per cent. more. They had done extraordinarily well in the home trade, and could scarcely expect to get more. It was evident that the prosperity of the firm depended upon the recovery of the export trade. Some disquiet has been caused among the railway firms of Sheffield and district by the London and North-Western Railway Company's announcement of the reconstruction of the locomotive and steel works at Crewe, covering an area of 160 acres. It is officially stated that the company intends to make its locomotive building and repair shops the largest of the kind in the country, while its new steel works equipment is to include mechanically charged furnaces up to 70 tons capacity. These steps of the railway company to supply its own requirements are likely to affect the volume of business coming to Sheffield in the future. Sheffield, however, has no apprehension on the score of the quality of its products.

Cutlery and Plate.

Generally speaking, the condition of these trades is very poor, and bright patches are few and far between. The ordinary home trade done through shopkeepers is at a low level, and some falling off of orders from the Colonies is reported. There are some substantial order books to be found in the city, and a significant feature is that some of these are at works which maintain the quality of their goods and obtain fair prices for them. On the other hand, there has been a falling off at several factories, owing to the completion of a very large contract for cutlery, electroplate, and cased goods placed by a soap company, who will distribute the articles in return for coupons. This contract had provided a considerable amount of work for the past two months. The sterling silver department is in a lifeless condition. Public purchases of silver services, plate, spoons and forks, have recently fallen off to a marked extent. Several of the large celluloid merchants have made reductions of 3d. or 4d. per dozen in the price of their celluloid handles.

Stainless Steel for Tramcars.

The application of stainless steel to new purposes has made rapid strides during the past few years, and efforts have been made to adapt it for, among other things, the fittings of tramcars, which are at present generally made of brass. The Sheffield tramways department is now giving a trial to stainless fittings, and one car has been equipped with them. No general decision is being taken as to an extended use of the fittings, until experience shows how they compare with brass, not only in initial but in working costs and in other respects. The capital cost is, of course, greater. Mr. W. R. Hardy, of Surrey-street, Sheffield, who is equipping the experimental car, states that the cost is about £100 per car. On the other hand, stainless material has many advantages in long life and especially in saving the expense of cleaning. Mr. Hardy says that one Corporation employs over forty men for cleaning brass, and that a general adoption of stainless steel would mean a saving in wages alone, at a moderate estimate, of £5000 per annum. Members of the trade consider that stainless steel for tramcar fittings may become a commercial proposition, but that it will be necessary to standardise the fittings throughout the country and to remodel some of them to simpler shapes than at present. It is more the working up and polishing, than the material itself, which is responsible for the high cost. Mr. Hardy's view is that the price will certainly be reduced when mass production is commenced, and that eventually stainless will be used on all cars, omnibuses, ships and other means of transport.

New Bridge at York.

A new bridge over the Ouse at Fulford, which is estimated to cost £56,000, is proposed by York Corporation, and the Streets and Buildings Committee has submitted plans of it to the Ministry of Transport, together with a request for a lump sum grant of not less than 50 per cent. of the expenditure. The drawings have been prepared by the British Reinforced Concrete Company. The figure referred to is for the complete bridge with lifting span and operating machinery. It includes a sum of £3600 for piles, if these are necessary after the foundations have been opened out, but does not include purchase of land or earth filling at either end of the bridge. The bridge is to be 360ft. long and 45ft. wide between parapets, with a carriageway of 30ft. The centre span of arched ribs will be 80ft., with a girder span of 35ft. on each side and a smaller span of 19ft. One of the girder spans will house the machinery for the lifting span, which will be of the bascule type. The height of the bridge above normal water level provides for 21ft. of head room under the arch span and 20ft. under the girder span.

Orders and Schemes.

Clayton Wagons, Ltd., of Lincoln, has received an order from the London and North-Eastern Railway Company for a special design of steam rail motor coach. The Buenos Aires Great Southern Railway Company has placed a contract with the Metropolitan Carriage, Wagon and Finance Company, Birmingham—a subsidiary of Vickers Ltd.—for 100 bogie brake vans. A scheme for the public electric lighting of Barlby, near Selby, has been sanctioned by the Ministry of Health. The current will be supplied from the works of the Olympia Oil and Cake Company, and the same company has also undertaken to carry out the work of installation. At Burton, the Electricity Committee has recommended the Town Council to install a new plant and carry out mains extensions, at a cost of over £60,000.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

The position in the Cleveland pig iron trade at the moment is very discouraging. The market has, in fact, relapsed into a state of complete paralysis, and until the coal crisis is settled, it seems idle to look for any improvement in business. The recent attitude of the Cleveland ironmasters gives no warrant for the assumption that they might be prepared to consider price reductions. Even if they were it is improbable that they could induce buyers to operate at the present juncture, and consequently there is no point in cutting quotations. Everything depends on the coal settlement, but if peace can be arranged without adding to fuel costs, orders may be more plentiful. Certainly some of the consuming works must be exhausting their supplies, and will probably come on to the market for more, directly the air is cleared. With regard to foreign business, there seems little hope unless prices fall, as Cleveland quotations are far too high for continental consumers, who have cheaper sources of supply nearer home. However, the Cleveland makers have no occasion to worry at present, as they have very small stocks and a fair number of unexpired contracts. Prices are unchanged, No. 1 Cleveland foundry iron being 72s. 6d.; No. 3 G.M.B., 70s.; No. 4 foundry, 69s.; and No. 4 forge, 68s. 6d. per ton. These are all home prices, and 6d. per ton more is asked for export iron.

Hematite Pig Iron.

The East Coast hematite pig iron trade presents no new features of moment. The demand still falls short, of the output, and stocks tend to increase. Competition for orders is consequently very keen, and mixed numbers are now down to 76s., with No. 1 quality at 76s. 6d. per ton.

Ironmaking Materials.

There is no change in the position of the foreign ore trade. Deliveries under running contracts continue on a heavy scale, but new business is rarely heard of. Best Rubio ore is quite nominal at 21s. 6d. per ton c.i.f. Tees. Coke prices are difficult to fix, as there are neither buyers nor sellers. The latter name 19s. per ton as the delivered price of good Durham furnace coke.

Manufactured Iron and Steel.

There is absolute stagnation in the manufactured iron and steel trade. Some of the rolling mills are badly in need of new orders. Prices generally are unchanged, although galvanised corrugated sheets are easier at £16 per ton of 24 gauge.

The Coal Trade.

Business is practically at a standstill in the Northern coal trade. Although producers report full stems to the end of the month, there are surpluses, and for these practically no competition; and holders to secure a prompt clearance are making slight discounts. Foreign consumers are not buying any coal locally, but are making inquiries in competing countries for fair quantities, and they are probably taking precautionary measures to insure supplies in the event of a stoppage in this country. There were expectations of the placing of the usual order for about 5000 tons of best gas coal by the Palmero Gas Works, tenders for which were dispatched a fortnight ago. It is reported, however, that the placing of the contract has been deferred, so that offers might be received from the United States. This indicates once more that for even relatively small supplies, buyers have a wide field of tenderers to choose from, and shows how great is the competition against British coals. Requirements of best steam coals have apparently been completed for a time, and the market has become practically nominal, with, however, full turns and firmly quoted prices. Best Blyth qualities are 16s. 6d., while Tyne primes are 15s. 6d. to 16s., and seconds keep to 15s. to 15s. 6d. Producers are comfortably settled with steam small business, and there are now not many sellers. Quotations range very steady at 8s. 6d. for bests, 7s. 9d. for seconds, and 10s. to 10s. 6d. for special descriptions. Durham gas coals are fairly well booked for this month. There is little new demand, however, and values are undisturbed. Best qualities are firm at 19s. to 20s., with special kinds at 20s. to 22s. Coking coals in quiet manner maintain a range of 15s. to 16s. Bunkers are in small supply, and 15s. 6d. to 16s. is named for ordinary kinds, and 16s. 6d. to 17s. 6d. respectively for bests and superiors. The coke trade remains idle. Stocks are abundant, but neither buyers or sellers are willing to operate under the present outlook. Buyers' ideas are much below those of makers. Gas coke is quoted 19s. to 20s.; patent oven cokes, 19s. to 21s.; beehive, 26s. to 30s.

Blast-furnacemen's Wages Unchanged.

Under the ascertainment issued this week the wages of blast-furnacemen employed at ironworks on the North-East Coast will remain unchanged for the next three months. The average net selling price of No. 3 Cleveland pig iron for the past quarter was certified at 65/10·58d. per ton, an increase of 1·57d. per ton as compared with the realised price for the previous quarter. The men's wages stand at 8·75 per cent. above the standard.

SCOTLAND.

(From our own Correspondent.)

Outlook Unchanged.

THE general situation in the steel, iron, coal and kindred industries is unchanged. In most cases the workshops and factories only manage to preserve a certain degree of activity, orders for most classes of material being of comparatively meagre tonnage. Shipbuilding contracts are still coming forward, and sooner or later the various industries interested must benefit. A considerable period of time must elapse, however, before the work can be brought forward far enough to create employment on a fair scale. Meanwhile, conditions are unsatisfactory, and are, of course, not improved by the uncertainty existing in the coal trade. Since the Easter holidays markets have been even quieter than formerly, and are likely to remain so until more settled conditions have been established.

Steel.

So far as the steel trade is concerned, makers are still in need of orders for plates and sections on home and export account. Inquiries are said to be more prolific, and hope is entertained that these may soon result in fair orders. The fixing of prices may induce some buyers who were wavering to place their orders, but makers do not anticipate much improvement in the meantime.

Steel Sheets.

There seems to be little falling off in the turnover in light steel sheets, though perhaps business is not just so easily secured now. As a rule, makers have not quite so much on hand as formerly in ordinary sheets, but no change is apparent in galvanised flat and corrugated descriptions. Prices have dropped a shade, but the tone is very firm nevertheless.

Iron.

The bar iron works continue to experience a lean time. Specifications are meagre and chiefly concerned with small lots. Export orders are scarce, and excite keen competition, while the home demand, on which makers chiefly depend, is far from satisfactory. Re-rolled steel bars and sections are no better off than iron, and altogether the industry is in a disappointing position.

Pig Iron.

Pig iron is a slow market. Consumers are not in a position to purchase on any great scale at present, and the average turnover does not in any way tax the output, meagre though it is meantime. The export demand is not sufficient to afford any relief, and conditions are more or less stagnant.

Coal.

The coal market has shown little movement since the holidays, and pending a settlement of affairs in the industry no improvement can be expected. Exporters, meantime, find great difficulty in securing orders from abroad and the collieries are in need of business in practically all descriptions of fuel. Foreigners are evidently purchasing fuel in other markets at a price that local collieries could not approach. Apart from Lanarkshire cells and splint and best Lothians steams, all descriptions of coal are rather poorly placed, and many colliery sidings are congested with wagons of unsold fuel. Even for the descriptions mentioned above the collieries would welcome fresh business. Ayrshire collieries present perhaps an exception to the rule, for the output from that district is comparatively well disposed of. Aggregate shipments for the past week amounted to 238,701 tons, against 272,165 tons in the preceding week and 209,244 tons in the same week last year. The home market is comparatively dull, as all kinds of fuel are in plentiful supply.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE labour position in the coal industry dominates the interest in this district, which is mainly dependent upon the export trade. At the moment of writing the outlook is still very obscure, and very few are bold enough to entertain or express very decided views as to what may happen at the end of the month. Certainly there is an inclination to be less optimistic regarding the success of the negotiations between the parties, though at the same time the feeling is held that the Government will by some means avert such a disaster as an actual stoppage. It is, however, unfortunately the case, that fears as to what may occur have already very much damaged the prospects of business for May. The uncertainty which has prevailed has brought operations to a standstill, except for supplies for shipment by the end of this month, and the position now is that the collieries and fuel works are so full up with orders for April that further business is practically rendered impossible. Stems all round are extremely tight, which is shown by the difficulties of shipowners in getting their steamers fixed up, except at rather lower rates of freight and with very long loading hours. Values of coal all round are higher for the small quantities which can be secured for this month's shipment, but as regards May loading it is no exaggeration to state that business is, to all intents and purposes, at a standstill. Even if there is no stoppage of work, it is to be feared that the majority of the collieries will have so few definite orders on their books that they will experience some difficulty in maintaining regular work at the pits during the first half of May. Of course, at the moment they are all very busy, and there is heavy loading pressure at all the docks. There was a good arrival of tonnage over last week-end, with the consequence that although there was one idle loading berth at Swansea and one at Port Talbot, there were seventeen steamers waiting their turn to get into berths.

South Wales Miners' Policy.

The Executive Council of the South Wales Miners' Federation has issued a statement regarding the Coal Commission report, which virtually sets forth its policy. They stand for the retention of national agreements and for opposition to district settlements of the general wage rate. It is opposed to any reduction of the present minimum percentage of 42·22 per cent. on the 1915 standard rates or the existing subsistence wage, while it protests against any system of family allowances. Any extension or variation of present hours of work is opposed, but the continuation of the subsidy is favoured as well as the adoption of measures for the establishment of prices on a remunerative basis. It considers that the Miners' Federation should be prepared to render assistance in co-operation with the coalowners in the establishment of district or national control of selling prices. The executive's recommendations were sent to all the lodges in this district so that they could decide their attitude in readiness for a South Wales conference to be held on the Thursday of this week.

Steel Works Closed.

Reference was made last week to the curtailment of work at the steel works at Llanelly belonging to Richard Thomas and Company, Ltd. Since then there has been further development of an untoward character, inasmuch as whereas the stoppage was to be of a partial nature, now the whole of the works are shut down, thus affecting 700 men. This is due to a dispute between the management and the locomotive men, who number about a dozen. The management stipulated that only one out of four locomotives had to be put into commission, but the men contended that this was insufficient to cope with the whole of the work, and they asked that a second should be used, which the management declined to agree to. The boiler firemen and the mill engine drivers raised the question of a re-adjustment of the bonus paid to them on the output, but a rejection of their proposals here again caused a deadlock, and the outcome is that the works are idle.

Dock Dues.

Shipowners have been notified through the secretary of their organisation that the Great Western Railway Company has withdrawn as from June 1st next the concession by which vessels can move from between Cardiff, Penarth and Barry for the purpose of loading or discharging, and be charged only one full dock due with the addition of a locking fee in accordance with an arranged scale. This concession had been in operation since March, 1925, since which time the traders and others at Newport had strongly agitated for its extension to the port of Newport. Their efforts unfortunately failed, and the Newport Shipowners' Association and the Corporation then advanced the contention that the introduction of the arrangement at Cardiff, Penarth and Barry was a violation of the pledge given by the company at the time of the amalgamation of the South Wales docks that its aim and object would be to hold the balance evenly between the various interests. The Great Western Railway Company has been advised that this claim is well founded, and therefore the interlocking arrangement at Cardiff, Penarth and Barry is to be withdrawn at the end of May.

Ship-repairing.

Ship-repairing firms in this district have had a very difficult time for the last few years owing to the keen competition from other repairing districts, both at home and abroad. The employers' Association therefore recently gave notice to the various trade unions of its desire to terminate the rates and rules at present in operation in this district, with a view to a revision in the rates of pay and working conditions. The object of the employers is to cut down their operating costs. Following up their action the employers sought a conference with the representatives of the trade unions concerned, and this conference was held at Cardiff on Monday. After a discussion the conference was adjourned and arrangements are to be made for another meeting.

Tin-platers Idle.

Following on the trouble at the steel works of Richard Thomas & Co., Ltd., at Llanelly, affecting the steel workers to the number of about 700, comes the news that tin-plate workers are now involved, as the result of which about 1200 men are altogether idle at Llanelly. The works concerned are the South Wales Tin-plate Works, the Richard Thomas Mills, Burry Works and Burry Extension. At all of these the mill departments were idle on Wednesday. The finishing departments are, however, able to continue working, but if the stoppage of the mills is prolonged, these departments will of necessity also become involved.

Current Business.

The market for prompt supplies of coal of all descriptions is very firm. In fact, the market is little short of being nominal, as coals for loading this month are scarcely obtainable, as the collieries are so fully booked up. Best Admiralty large coals are quoted up to 25s. 6d., and best smalls up to 16s. 6d. Patent fuel and coke are also firm. Anthracite coals are a stronger market, as the loading of tonnage for Canada has started, and, furthermore, there is a better demand for coals inland, in consequence of the fear of trouble at the end of the month.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE STEEL BAND CONVEYOR AND ENGINEERING COMPANY Ltd., formerly Steel Belt Conveyors, Ltd., asks us to announce that it has changed its address from Norwich Union Chambers, Congreve-street, Birmingham, to Barker-street Works, Parade, Birmingham. Its telephone number, Birmingham, Central 5454, and its telegraphic address, Simplicity, Birmingham, remain as heretofore.

MR. JAMES GEORGE MCLEAN, who has for the last fourteen years been agent and superintending engineer in the North Midlands and in the North-East Coast of England district of Edward Bennis and Co., Ltd., asks us to announce that he has severed his connection with that company, and that he now represents the Crosthwaite Engineering and Furnace Company, Ltd., of York-street, Leeds.

CONTRACTS.

WILLIAM BEARDMORE AND CO., Ltd., inform us that their locomotive department at Dalmuir, Glasgow, has received an order for twenty 0-6-2 side tank locomotives from the London and North-Eastern Railway.

SIR WILLIAM ARROL AND CO., Ltd., have received from the London, Midland and Scottish Railway Co. an order for twenty-one level-luffing cranes for Grangemouth Harbour. The maximum loads to be lifted vary from 2 to 5 tons. The same firm has also received orders recently from other sources for eight of its level-luffing cranes for harbour work in Africa.

ENGINEERS' CLUB, BIRMINGHAM.—The annual meeting of members of the Engineers' Club, Birmingham, was held at the Club House, Waterloo-street, Birmingham, on Monday, March 29th. It was the first annual meeting to be held since the members have taken possession of their club premises, which have been obtained by the fusion of the Engineers' Club and the Midland Conservative Club, both clubs maintaining their own separate identities and organisation with full and equal use of the Midland Conservative Club premises. Club rooms are available for meetings of technical societies and already the Midland Branch of the Institute of British Foundrymen and the Chemical Society have taken advantage of these facilities, and requests for accommodation are now being received from other societies.

ENGINEERING GOLFING SOCIETY.—The Spring Meeting of the Engineering Golfing Society will be held at Beaconsfield, on Thursday, April 29th, by the courtesy of the Golf Club. The following is the programme for the day :—In the morning there will be 18 holes stroke competitions under handicap for the "President's Challenge Cup," presented by Sir Alexander Kennedy, for members in the First Division, with handicaps of 10 and under, and for the "Wilson Challenge Cup," presented by Mr. R. P. Wilson, for members in the Second Division, with handicaps of 11 and over. A memento and a second prize will be given in each division. There will also be a prize for the best scratch score, presented by the Captain, Mr. D. T. Powell. In the afternoon there will be an 18-hole round, four-ball foursomes match play against bogey, for the "Timmis Challenge Cups," presented by Mr. E. W. Timmis. There will be two first and two second prizes for this competition. Entries, which have to be made on a special form, must reach the hon. secretary, Mr. G. M. C. Taylor, Caxton House, Westminster, S.W. 1, by the first post on Friday, April 23rd.

FARADAY HOUSE.—On the results of the entrance scholarship examination held at Faraday House Electrical Engineering College on April 7th, 8th and 9th, the following awards have been made by the Governors of the College :—Ernest M. Noble, Holborn Estate Grammar School, the "Faraday" Scholarship of 50 guineas per annum, tenable for two years in college and one year in works ; Charles B. Forgan, Roan School, Greenwich, the "Maxwell" Scholarship of 50 guineas per annum, tenable for one year in college and one year in works ; Ian J. Farmbrough, Stationers' Company's School, Hornsey, an Exhibition of 40 guineas per annum tenable for one year in college and one year in works ; Richard P. E. Tabb, Haberdashers' Aske's Hampstead School, an Exhibition of 30 guineas per annum, tenable for one year in college and one year in works ; William R. Crookes, East Anglian School, Bury St. Edmunds, an Exhibition of 30 guineas per annum, tenable for one year in college and one year in works. Entrance prizes of ten guineas each were also awarded to John H. Bayton, the Nautical School, Pangbourne, and John C. McMahon, the King's School, Peterborough.

THE SIR JOHN CASS TECHNICAL INSTITUTE.—The Department of Metallurgy of the Sir John Cass Technical Institute has arranged for a course of lectures on "Heat Treatment of Metals and Alloys," to be delivered by Mr. C. Coldron Smith, M.Sc., A.R.S.M. This course is arranged for those interested in the after-treatment of manufactured iron and steel and the principal industrial alloys, especially to those engaged in the motor car, aeroplane and similar industries. The course will be held on Wednesday evenings, from 7 to 10 p.m., and the first lecture was delivered on the 14th inst. The Department has also arranged for another course of lectures on "The Mechanical Testing of Metals and Alloys," to be delivered by Mr. L. Singlehurst Ward, B.Sc. The course will consist of lectures accompanied by suitable laboratory work and practical demonstrations on the use of the principal types of testing machines, and will be given on Thursday evenings, from 7 to 8 p.m., the first having been delivered yesterday. Further particulars may be obtained on application to the Institute, Jewry-street, London, E.C. 3.

THE INSTITUTION OF STRUCTURAL ENGINEERS.—The annual dinner of the Institution of Structural Engineers was held on Monday evening, April 12th, under the presidency of Sir Charles Ruthen, Director-General of Housing. Sir Charles is intimately associated with the Piccadilly Hotel, and it was for that reason, no doubt, that the dinner was held in the French Restaurant of that hotel and was enlivened by passages from the Piccadilly Cabaret. The attendance was large, about five hundred, and since dancing till two in the morning was to follow the dinner, ladies were nearly as numerous as men. The organisation was admirable and the dinner could not have been beaten ; but we are not sure that the experiment was a complete success. For one thing, some of the speakers had to cross the floor, mount a soap-box covered in white paper and talk to a microphone, and for another it may be doubted if caperings in cabaret costumes can be successfully interspersed with the speeches at the dinner of a learned society. In any case, every one of the speakers, amongst whom were included Sir Alfred Mond, Sir William Ellis, Mr. J. M. Moncrieff, Mr. H. J. Deane, Mr. H. G. Wells, and Mr. Justice Eve, all seemed to suffer a little from the unusual conditions. Moreover, the last speech was not over till past 11.30 ! If the experiment is worth repeating, the dinner and the speeches should be got rid of first and the amusements be attended to afterwards.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/– to 21/–
(1) Spanish	18/– to 21/–
(1) N. African	18/– to 21/–
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/3

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) Scotland—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. Coast—		
Hematite Mixed Nos.	3 16 0	3 16 0
No. 1	3 16 0	3 16 6
Cleveland—		
No. 1	3 13 6	3 14 0
Siliceous Iron	3 12 6	3 13 0
No. 3 G.M.B.	3 10 0	3 10 6
No. 4 Foundry	3 9 0	3 9 6
No. 4 Forge	3 8 6	3 9 0
Mottled	3 8 0	3 8 6
White	3 8 0	3 8 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 3 0 to 3 4 0	
,, Forge	2 15 0 to 2 16 0	
(3) Derbyshire—		
No. 3 Foundry	3 6 0 to 3 7 0	
Forge	3 0 0 to 3 2 0	
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (a) / 4 10 0 (b) / 4 15 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 0 0	—
Second Quality Bars	9 15 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 0 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 5 0 to 12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	7 10 0	7 0 0
Sections	7 0 0	—
Steel Sheets, under 3/16in. to ¼in.	9 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£16 to £16 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	7 10 0	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
Manchester—		
Bars (Round)	8 0 0 to 8 5 0	
,, (others)	8 0 0 to 8 5 0	
Hoops (Best)	13 5 0	13 0 0
,, (Soft Steel)	10 0 0	9 15 0
Plates	7 15 0	—
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	6 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 0 0	
Billets and Sheet Bars	6 0 0 to 6 2 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	15 10 0 to 16 0 0	
Angles	7 0 0	—
Joists	7 0 0	—
Tees	8 0 0	—
Bridge and Tank Plates	7 15 0	—
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/1½ to 19/6
Block Tin (cash)	284 5 0
,, (three months)	270 5 0
Copper (cash)	56 17 6
,, (three months)	57 15 0
Spanish Lead (cash)	29 2 6
,, (three months)	28 12 6
Spelter (cash)	32 11 3
,, (three months)	33 2 6
Manchester—	
Copper, Best Selected Ingots	62 5 0
,, Electrolytic	65 17 6
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 0½
Brass Tubes (Basis Price)	0 0 11½
,, Condenser	0 1 2
Lead, English	31 7 6
,, Foreign	30 10 0
Spelter	31 15 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/1 per lb.	
Ferro Tungsten	1/9½d. per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/–
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 per unit	scale 5/– per
,, ,, 75 p.c.	£20 10 0 per unit	scale 6/– per
,, Vanadium	14/6 per lb.	
,, Molybdenum	6/– per lb.	
,, Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	10/– per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/0
,, ,, Ell	15/9
,, ,, Splint	16/9 to 19/–
,, ,, Trebles	15/6
,, ,, Doubles	13/6
,, ,, Singles	13/1½
Ayrshire—	
(f.o.b. Ports)—Steam	15/6
,, ,, Jewel	16/6
,, ,, Trebles	15/9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/–
Trebles	13/6 to 14/6
Doubles	13/6
Singles	12/6
Lothians	
(f.o.b. Leith)—Best Steam	14/6
Secondary Steam	13/6
Trebles	14/6
Doubles	14/–
Singles	12/9

ENGLAND.

(8) N.W. Coast—	
Steams	23/–
Household	40/– to 48/–
Coke	24/–
Northumberland—	
Best Steams	16/3 to 17/–
Second Steams	14/– to 14/6
Steam Smalls	8/– to 8/6
Unscreened	13/– to 13/6
Household	20/– to 22/–
Durham—	
Best Gas	17/6 to 18/–
Second	14/6 to 15/–
Household	20/– to 22/–
Foundry Coke	18/– to 20/–
Sheffield	Inland.
Best Hand-picked Branch	31/– to 34/– —
Barnsley Best Silkstone	28/– to 30/– —
Derbyshire Best Brights	26/– to 28/– —
,, ,, House	24/– to 25/– —
,, ,, Large Nuts	17/– to 20/– —
,, ,, Small	12/6 to 14/– —
Yorkshire Hards	17/– to 19/6 —
Derbyshire Hards	16/– to 19/– —
Rough Slacks	10/– to 12/6 —
Nutty Slacks	7/6 to 9/– —
Smalls	3/6 to 6/– —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 16/– to 17/–

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	25/– to 25/6
Second ,, ,,	23/– to 24/6
Best Dry Large	22/– to 24/6
Ordinary Dry Large	21/– to 22/–
Best Black Vein Large	24/– to 24/6
Western Valley Large	23/6 to 24/–
Best Eastern Valley Large	23/– to 23/6
Ordinary ,, ,,	21/6 to 22/–
Best Steam Smalls	16/– to 17/6
Ordinary ,,	14/6 to 16/–
Washed Nuts	19/– to 26/–
No. 3 Rhondda Large	26/9 to 27/3
,, ,, Smalls	16/6 to 17/–
No. 2 ,, Large	22/– to 24/–
,, ,, Through	18/– to 19/–
,, ,, Smalls	14/– to 15/–
Foundry Coke (export)	40/– to 50/–
Furnace Coke (export)	25/– to 30/–
Patent Fuel	21/6 to 24/–
Pitwood (ex ship)	25/– to 25/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/– to 40/–
Seconds	32/6 to 35/–
Red Vein	27/– to 29/–
Machine-made Cobbles	50/– to 52/6
Nuts	50/– to 52/6
Beans	42/6 to 44/–
Peas	23/– to 25/–
Breaker Duff	7/3 to 7/9
Rubbly Culm	12/– to 12/6
Steam Coals:	
Large	22/6 to 23/6
Seconds	20/– to 22/–
Smalls	10/– to 14/–
Cargo Through	16/– to 17/–

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—fo.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/–, with fluctuations according to analysis; open market 17/6 to 19/– at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Advancing Prices.

THE increase of 30 per cent. in import duties is only partly responsible for the higher prices of all kinds of products. The placing of heavier burdens upon the manufacturing industries by the voting of new taxes, the proposed increased railway rates, and the further surprising depreciation of the franc at a time when provision had been made for additional revenue, have also influenced values, which appear, therefore, destined to move steadily upwards. So far as the home market is concerned there is no marked activity, but a fair amount of business is being done, and it is mainly for export that the contraction is particularly noticeable. When raw material prices are rising, manufacturers hesitate to quote, as they cannot tell whether they will make a profit or not. This feeling of uncertainty will probably increase until the financial situation is placed upon something like a sound basis and the franc is stabilised. After benefiting from the temporary advantages of a falling franc, manufacturers find that the pendulum is swinging the other way, and while there is usually still a good margin in favour of French makers, it is being rapidly reduced so far as foreign business is concerned. Even on the home market the situation is far from satisfactory. One of the French railway companies has refused tenders for a number of locomotives on the ground that they are much too high, and French builders are now entreating the company not to place the order in Germany on account of reparations.

Paris Water Supply.

Considering the unanimity with which the various Chambers of Commerce in the Department of the Loire are protesting against the scheme for supplying Paris with water from the Vals de Loire, it may be presumed that the Paris Municipal Council is once more endeavouring to overcome local opposition to a proposal which is regarded as capable of providing the city with all the water it may need in the future. In the opinion of the Paris engineers, the underground water in the Vals de Loire is of excellent quality and is practically inexhaustible, and pumping experiments have been carried out for some years past to prove that the required quantity of water for the needs of Paris can be brought to the surface without affecting the level of the river Loire or of depriving the local population of their present ample supplies. The various local boards and Chambers of Commerce, however, refuse to accept the evidence of tests which are necessarily carried out on a small scale, and even though local interests should not be seriously jeopardised there is still a strong objection to Paris drawing upon the Vals de Loire for its supplies of water. The Chambers of Commerce have therefore readily seized upon the alleged superior claims in favour of the Chabal scheme, which aims at the creation of vast reservoirs in the upper valley of the Seine. The chambers of Nevers, Orleans, Blois, Bourges and others point out that while the reservoirs would provide Paris with all the water it needed, they would have the further advantage of regularising the river Seine, preventing floods and of supplying electric energy. The scheme, moreover, could be carried out much more rapidly and at far less cost than the putting down of powerful and extensive plants necessary for conveying water from the Vals de Loire. The alleged advantages of the Chabal scheme are not universally recognised, and there are many who doubt whether the reservoirs can be relied upon to supply water of good quality, but the Paris Municipal Council has decided to make an experiment with one or two reservoirs on the Chabal plan.

Motor Fuels.

A report by M. Guiselin upon the operations of the Committee, which was formed early last year by the Société des Ingénieurs Civils de France to investigate the various inventions and processes for the synthetic production of motor fuels, conveys the impression that very little has been done in the way of practical achievement. The results are, in fact, disappointing. It was hoped that inventors would have readily availed themselves of the opportunity offered them of having their processes examined and tested scientifically and impartially. So many new fuels were introduced with claims of a more or less exaggerated character that inventors might have been expected to accept the offer of the Committee to see if the claims were justified or not. The first to refuse was M. Makhonine, whose process for producing motor spirit direct from crude oils was so strongly recommended by the Government, following upon tests carried out on military vehicles at Vincennes, that it appeared a heresy to question the value of the system. Nevertheless, M. Makhonine failed to exploit his patents in this country, and nothing further has been heard of his system since a company was formed in Brussels several months ago. All the other systems for producing motor fuels, synthetic or otherwise, have failed to realise their early promise. It is quite possible that some of them may possess merits or may be based upon ideas capable of development under expert guidance, and for that reason it is to be regretted that inventors should fail to respond to the offer of the Committee of the Société des Ingenieurs Civils to demonstrate the actual value of their processes. Of the large number of new motor fuels introduced during the past two years the only system which has successfully entered upon a practical stage is the charcoal suction gas plant.

Agricultural Engineering.

The agricultural engineer in this country is not a manufacturer of agricultural machinery but an engineer trained to the practical and scientific work of agriculture. To commemorate the fiftieth anniversary of the leading State college the association of old students, comprising about 2000 members, is issuing a work that will cover all phases of the agricultural industry, and will be a complete record of scientific and engineering progress. The list of the subjects dealt with, including rural electrification, suction gas tractors, and farm machinery generally, shows that the agricultural engineer is a man of particularly wide attainments and a chemist as well.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

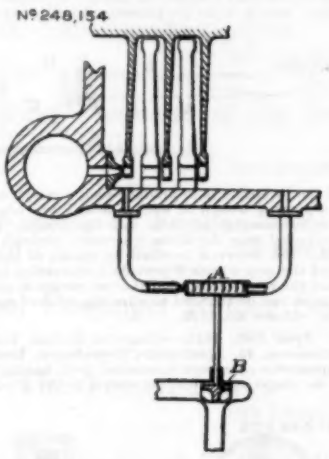
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

248,154. January 31st, 1925.—REHEATER STEAM TURBINES. The English Electric Company, Ltd., 28, Kingsway, London, W.C. 2, and J. P. Chittenden, Willans Works, Rugby.

This invention deals with steam turbine power plants in which reheating of the steam is effected between the stages by the use of a fluid—for instance, oil or mercury—which serves as a carrier of heat from a place of supply, such as the boiler-house, to the neighbourhood of the turbine, where, in a suitable heat interchanger, it imparts heat to the steam. With such an arrangement the rate of supplying heat for reheating purposes will generally be controlled by the rate of circulation of the oil or other heat carrying fluid in the system. Accordingly, by

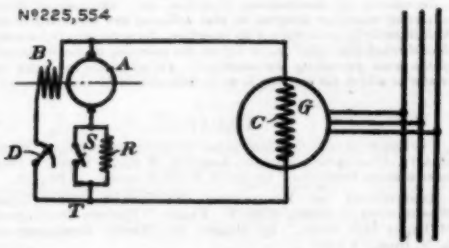


controlling the speed of a circulating pump for this fluid, regulation of the reheating may be effected. This regulation is carried out by making the speed of this pump dependent upon the quantity of steam passing through the main turbine with which the reheating apparatus is associated. This dependence may be obtained by utilising the pressure of the steam at some point or points between the main throttle valve and the condenser as a measure of the quantity of steam passing and causing this pressure to act upon the means for driving the pump or on some device for controlling such driving means. The scheme of the apparatus is fairly evident in the drawing, in which A is a turbine operated by the drop in pressure along the main turbine, and B is the pump used to circulate the reheating medium.—*March 4th*, 1926.

DYNAMOS AND MOTORS.

225,554. November 25th, 1924.—IMPROVEMENTS IN OR RELATING TO THE DE-EXCITATION OF ELECTRIC GENERATORS, Siemens-Schuckertwerke Gesellschaft mit beschrankter Haftung, of Siemensstadt, near Berlin.

The first part of this specification is devoted to a discussion on the disadvantages of the usual methods of de-energising the field magnets of electric generators and the improved arrangement which is designed to overcome these disadvantages is then described. G is the generator with its exciting winding C. The generator is excited by the exciting machine A with a shunt winding B, which can be adjusted in the usual manner to suit the load by means of a regulating resistance D. Between the armature of the machine A and the branching off or tapping point T of the two exciting circuits there is a resistance R and a



switch S. Under normal working conditions the resistance R is short-circuited by the switch S. For the purpose of de-excitation the switch S is opened. The field energy of the generator G will then surge back to the exciting machine A, which will have its poles reversed. The insertion of the resistance makes the whole exciting circuit capable of oscillating. It is adjusted in such a manner that instead of the direct currents, damped alternating currents will be produced in the exciting circuit. For assisting the disappearance of the currents the shunt regulator D can be moved according to the requirements, or a separate resistance may be switched into the shunt circuit of the exciting machine simultaneously with the resistance R. A curve is given in the specification showing the manner in which the exciting current actually disappears.—*February 25th*, 1926.

248,177. February 28th, 1925.—IMPROVEMENTS IN OR RELATING TO DYNAMO-ELECTRIC MACHINES, Diamond Coal Cutter Company, Ltd., and Percy Huggins, both of Stennard Works, Wakefield.

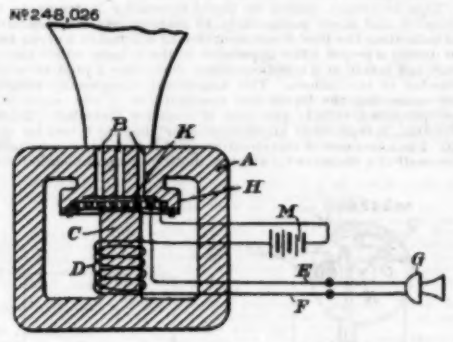
This invention relates more particularly to the motors used for coal cutting purposes, but also to other types of machine. In the manufacture of dynamo-electric machines it is found advantageous to assemble the windings in cores or bodies having slots completely open at the periphery and then to close the mouth of each slot by a strip or wedge of magnetic material, and the chief object of the present invention is to provide an improved type of closing strip or wedge for this purpose. The slot closing members or wedges C are made from a fabric composed of wires A or strands of a ferrous nature of high magnetic permeability woven with strands of insulating material B, the wires being arranged in the wedge so as to extend across the slot, directly or in a slanting manner. The arrangement of wires of high permeability therefore decreases the magnetic reluctance across

the slot opening, but the production of eddy currents in the wedge is substantially eliminated owing to the discontinuity of the metallic parts of the wedge along the slot. The mixed fabric may be made solid by treatment with suitable insulating material D in which the strands are embedded and insulated from each other and the fabric may be woven in sheets which are subsequently cut up into widths suitable for the wedges, or strips of the desired width may be made directly. The strips may be retained in the slots by dovetailing into the tops of the teeth of the core and by other methods and may, after insertion, be expanded by pressure or otherwise so as to make more intimate contact with the sides of the slots.—*March 4th*, 1926.

TELEGRAPHS AND TELEPHONES.

248,026. October 27th, 1924.—IMPROVEMENT IN LOUD-SPEAKING TELEPHONE RECEIVERS, *The Dubilier Condenser Company* (1921), *Ltd., of Ducon Works, Goldhawk-road, Shepherd's Bush, London, W.* 12.

The sound reproducing diaphragm is made of non-metallic material of a rather inert nature, so that the diaphragm has a negligible natural period of vibration. A casing of magnetic material is shown at A having openings B leading into a horn. An extension C serves as the core of an electro-magnet. The core C and a winding D together form the usual operating electromagnet of the receiver. Current may be supplied to the winding D by means of conductors E and F. This current may be modulated by the use of any desired type of sound transmitter G, which may be such as is used in ordinary telephone practice. On the ring H the diaphragm K is clamped by means of a ring. The diaphragm consists of a non-metallic

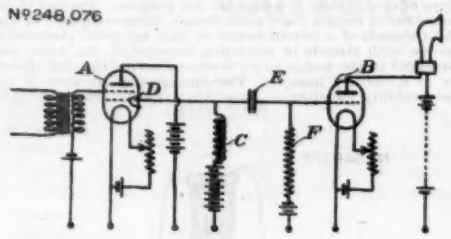


material of small inertia. The diaphragm consists preferably of silk tissue on which is superimposed a spiral winding of conducting wire. In order that the wire shall have no natural period of its own it is preferably of very fine gauge, and the preferred construction is to interweave the fine wire with the silk. The spiral is connected at its inner and outer ends to a battery M. When the modulated current is supplied to the winding D a flux is generated, flowing through the pole piece C and returning to the other pole piece of the magnet over the magnetic paths established by the casing A. At the same time a steady flux is being produced in the diaphragm, giving it what are substantially magnetic characteristics of its own, in accordance with well-known magnetic theory, so that the diaphragm will be caused to vibrate in accordance with the intensity, period and various characteristics of the currents which are being transmitted to the winding D.—*March 1st*, 1926.

248,076. November 27th, 1924.—IMPROVED MEANS FOR PRODUCING MAGNIFICATION WITH A FOUR-ELECTRODE VALVE AND CIRCUITS THEREFOR, Marconi's Wireless Telegraph Company, Ltd., of Marconi House, Strand, London, W.C. 2, and Ernest Walter Brudenell Gill, of Merton College, Oxford.

According to this invention the inner grid of a four-electrode valve is employed as the output anode and is charged through a choking coil, whereby very high magnification is obtained. The diagram shows a circuit diagram for a two-stage audio frequency amplifier. The first valve A is of the four-electrode type and the second valve B is a triode connected in cascade with the first valve. C is a choke through which the inner grid D of the valve A is charged, and E is a condenser through which the amplified impulses are applied to the grid of the triode B. F is the usual high-resistance or grid leak for the triode. It will be observed that with this arrangement the choke C has in parallel with it (through the condenser E) the grid leak F.

This, coupled with the fact that the choke is never a perfect one, tends to remove dependence upon frequency so that in practice there is substantially no frequency distortion. A circuit

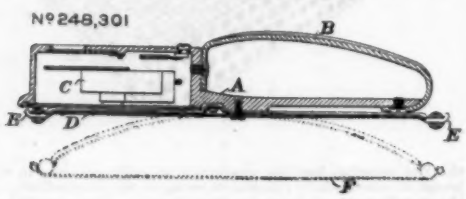


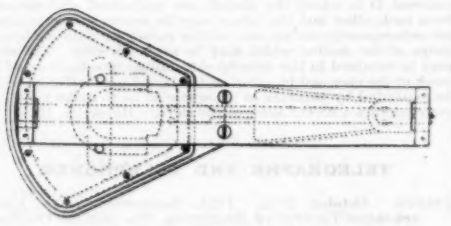
which is similar in general may be employed, in which the four-electrode valve functions as a high-frequency amplifier or as a rectifier.—*March 1st*, 1926.

MEASURING AND TESTING INSTRUMENTS.

248,301. December 17th, 1925.—Devices for Measuring Temperatures, J. L. Orchard, Boxmoor Cottage, Arbury-road, Cambridge, and the Cambridge Instrument Company, Ltd., Chesterton-road, Cambridge.

This instrument is intended for taking the temperature of rolls and other bodies having curved surfaces, and is of the thermo-couple type. It comprises a framing A, with a handle B,

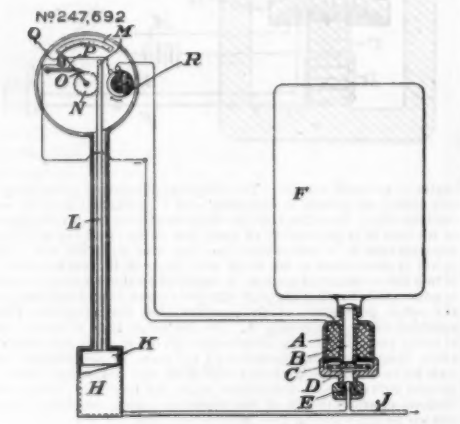




that accommodates a galvanometer C. Beneath the frame there is a long leaf spring D fitted with hooks E E at the ends. The thermo-couple F is in the form of a thin strip, and is slipped over the hooks, much in the same fashion as the string of a bow. When the instrument is pressed on to a curved surface, the thermo-couple adapts itself to the curvature, and a steady reading of the galvanometer, which is a measure of the temperature, is quickly obtained.—*March 4th*, 1926.

247,692. September 11th, 1925.—Liquid-measuring Instruments for Vehicles, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, Reginald Charles Clinker, of "Tryfn," Old Bilton, near Rugby, and Henry William Hugh Warren, of "Lynn," St. Andrew's-road, Earlsdon, Coventry.

This invention relates to liquid-measuring instruments for vehicles and more particularly to instruments for measuring or indicating the flow or consumption of a liquid in a given time or during a period while apparatus on the vehicle, which may or may not rotate at a constant speed, completes a predetermined number of revolutions. The instrument is especially adapted for measuring the liquid fuel consumption of the engine of a self-propelled vehicle per unit of distance travelled. In the drawing A represents an electromagnet having a tubular core B. The lower end of this electromagnet is formed, so as to make one wall of a chamber C, which is in direct communication with

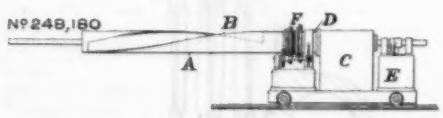


the exit and inlet conduits in the system. The chamber C may contain a flexible diaphragm having an armature secured to it in proximity to the end of the tubular core B, or, as shown, a casting D provided with holes for the passage of fluid, and the casting D may be loosely arranged beneath the end of the core or mounted on a spring blade. When the electromagnet A is energised the armature D is brought into contact with the end of the core, so as to close the passage. When the electromagnet is de-energised, the armature D drops and fluid can flow through the tubular core B into the chamber C and from there be passed through the exit E to wherever it is required. This cock is utilised in apparatus for measuring and indicating the rate of withdrawal of liquid fuel from the tank F on a self-propelled vehicle. The apparatus comprises an auxiliary chamber H connected to the carburetter by a pipe J, and to the exit E of the cock. A float K in the chamber H carries a light connecting-rod L having a rack M at its upper end, and the rack operates a pinion N, which carries a needle O movable over a scale. A pawl P controlled by an electromagnet Q is provided for the purpose of preventing the instrument from resetting before the reading is taken. The energisation of the electromagnets A and Q is controlled by a contact disc R, driven from the speedometer or wheel of the vehicle. When the electromagnet A is de-energised, liquid fuel passes from the tank F through the cock to the carburetter pipe J and to the chamber H. When the contact disc R closes the circuit of the electromagnet Q the needle P is at zero, and the pawl P is raised. As the disc R moves round in a clockwise direction, it closes the circuit of the electromagnet A, and the armature is attracted and the cock closes. The fuel supply to the carburetter is then taken from the auxiliary chamber H and the needle O being free starts to register. The circuit of the electromagnet Q subsequently opens, and the pawl P drops, thus locking the needle O. When the circuit of the electromagnet A has been closed for a period, during which the vehicle has run a predetermined distance, the contact disc R reopens the circuit and the cock opens. This results in a rush of liquid fuel from the tank F into the chamber H and carburetter pipe J, but the pawl P prevents resetting of the instrument before the reading is taken. The circuit of the electromagnet Q subsequently closes to lift the pawl P and allow the instrument to reset to zero.—*February 25th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

248,180. March 9th, 1925.—Centrifugal Casting Machines, Centrifugal Castings, Ltd., J. E. Hurst, and E. B. Ball, Kirkstyle-road, Kilmarnock.

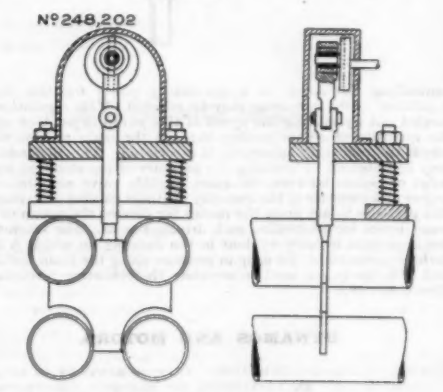
In this specification it is stated that in producing castings by means of centrifugal apparatus, and in particular in the production of castings of considerable length, it is important to ensure that a constant quantity of metal is deposited in a given unit of time, and at some predetermined initial velocity. The



object of the invention is to produce such a result, and for this purpose a pouring trough A, with a helical weir edge B is employed for introducing the metal into the mould. The molten metal is supplied from the tilting reservoir C through the hollow spindle D. The reservoir is tilted by means of the hydraulic gear E and the gear wheels F provide a connection between the trough and the reservoir, so that the two rotate in unison. The train of gears can be changed to alter the relative speeds of the two parts.—*March 4th*, 1926.

248,202. April 15th, 1925.—Cleaning Boiler Tubes, J. P. Martinussen, 35, Amaliegade, Copenhagen, Denmark.

This apparatus comprises a hammer tool, having a hammer head in the shape of a cross—as shown in the illustration—to



enable four quarters of four tubes to be treated simultaneously. This hammer head is operated by an excentric fitted in a casing which bears on the boiler tubes with an elastic support, and is driven by any convenient motor.—*March 4th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Petroleum and its Products" by Mr. J. Venn Stevens. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Paper, "Modern Development of Paper Mill Plant," by Messrs. W. Worby Beaumont and L. N. Burt. 6 p.m.

Institution of Municipal and County Engineers.—Town Hall, Manchester Old-road, Middleton. North-Western District meeting. 11 a.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Automobile Lighting, Starting, and Ignition," by Mr. T. L. Allison. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1. Discourse, "The Quest for Economic Plants," by Dr. A. W. Hill. 9 p.m.

TO-DAY AND SATURDAY, APRIL 17th.

Optical Convention, 1926.—Imperial College of Science and Technology, Imperial Institute-road, London, S.W. 7.

SATURDAY, APRIL 17th.

Institution of Civil Engineers.—Students' visit to the Littleton Reservoir of the Metropolitan Water Board.

North of England Institute of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. "The Contributions Made by the Microscopical Study of Coal," by Dr. Reinhard Thiessen. 2.30 p.m.

MONDAY, APRIL 19th.

Institution of Electrical Engineers: South Midland Students' Section.—Benn Buildings, Rugby. Paper, "Induction Motors," by Mr. D. G. Sandeman. 7 p.m.

TUESDAY, APRIL 20th.

Chemical Engineering Group.—White Horse Hotel, Congreve-street, Birmingham. Joint meeting with Birmingham Section. Papers on "Weighing and Measuring Instruments," by Messrs. W. A. Beaton and H. R. Trost. 5.30 p.m.

Institute of Marine Engineers.—85–88, The Minories, Tower-hill, London, E. 1. "Bearing Metals," by Mr. W. Griffiths. 6.30 p.m.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Experiments on Laminated Springs," by Mr. H. S. Rowell. 7.30 p.m.

WEDNESDAY, APRIL 21st.

Institution of Automobile Engineers.—Chamber of Commerce, New-street, Birmingham. Birmingham Graduates' meeting. Paper, "Gear Boxes," by Mr. E. J. Hewetson. 7.30 p.m.

Institution of Municipal and County Engineers.—Town Hall, Melksham, Wilts. Southern District meeting. 11 a.m.

Society of Glass Technology.—Applied Science Department of the University, St. George's-square, Sheffield. Ninth annual general meeting followed by ordinary meeting. 2.30 p.m.

THURSDAY, APRIL 22nd.

Institution of Automobile Engineers.—Training School of Vauxhall Motors, Ltd., Luton. Luton Graduates' meeting. Paper, "The Elements of Touring Engine Design," by Mr. C. L. Ensor. 7.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Seventeenth Kelvin Lecture, "The Mechanics of the Electric Field," by Sir J. J. Thomson. 6 p.m.

FRIDAY, APRIL 23rd.

Institute of Metals: Swansea Local Section.—Metallurgical Department, University College, Singleton Park, Swansea. Annual general meeting. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "What Our Foreign Competitors are Doing," introduced by Mr. F. J. Hookham. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Question and Discussion evening. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society's Rooms, Newcastle-upon-Tyne. Paper, "High-powered Oil Engines," by Mr. W. S. Burn. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, London, W. 1.—Discourse, "Luminous Discharge Through Rare Gases," by Professor R. Whiddington. 9 p.m.

SATURDAY, APRIL 24th.

Institute of Marine Engineers.—85/88, The Minories, Tower-hill, London, E. 1. Juniors' Social and Dance. 7 p.m.

MONDAY, APRIL 26th.

Institution of Structural Engineers.—Abbey House, Victoria-street, London, S.W. 1. Students' meeting. Discussion on "Theory *versus* Practice," opened by Mr. Ewart S. Andrews. 6 p.m.

Railway Club.—65, Belgrave-road, London, S.W. 1. Paper, "The Principles of Signalling," by Mr. L. Hiller. 7.30 p.m.

TUESDAY, APRIL 27th.

Institute of Metals: North-East Coast Local Section.—Electrical Engineering Theatre, Armstrong College, Newcastle-on-Tyne. Annual general meeting. 7.30 p.m.

Junior Institution of Engineers.—Monico Restaurant, Piccadilly-circus, London, W. 1. Annual dinner. 6.30 for 7 p.m.

WEDNESDAY, APRIL 28th.

Institution of Automobile Engineers.—Birmingham Graduates' Visit to the Works of Morris Engines, Ltd., Gosford-street, Coventry.

Institution of Automobile Engineers: North of England Centre.—College of Technology, Manchester. Lecture on "L.G.O.C. Methods of Omnibus Repair," by Mr. G. Rushton. 7.30 p.m.

THURSDAY, APRIL 29th.

Engineering Golfing Society.—The course of the Beaconsfield Golf Club. Spring Meeting. 10 a.m.

FRIDAY, APRIL 30th.

Institution of Electrical Engineers: Scottish Centre.—Y.M.C.A. Hall, Constitution-road, Dundee. Lecture, "The Past, Present and Future Development of Wireless Telephony," by Captain P. P. Eckersley. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion, "Marine Oil Engines in Practice," introduced by Mr. C. W. J. Taffs. 7 p.m.

Junior Institution of Engineers.—Royal United Service Institution, Whitehall, London, S.W. 1. Gustave Canet Memorial Lecture, "Air Transport," by Air Vice-Marshal Sir W. Sefton Brancker. 7.30 p.m.

CALENDARS, DIARIES, &c.

A. C. Potter and Co., Grantham.—Pocket diary for 1926.

T. Bolton and Sons, Ltd., 168, Regent-street, W. 1.—Pocket diary for 1926.

Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester.—A copy of the "Girl" calendar, with monthly tear-off sheets.

Trojan Service Manual.—Everyone knows the Trojan motor car and motor lorry. It is not only different from all others in appearance, but its mechanical features break away from conventional lines, particularly the engine, which is a horizontal four-cylinder unit, with two cylinders superposed on the other pair, and each vertical pair driving on the same crank pin. The makers, Leyland Motors, Ltd., Leyland and Kingston-on-Thames, have just issued an admirable handbook to the whole mechanical equipment of the vehicle. It is clearly illustrated with drawings and sectional views, and appears to leave unsolved no problem with which the owner may find himself faced.